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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 28045, 28085, 28339, 28376, and 28471.

27884 (AECL-2679) GRAVIMETRIC SAMPLING IN THE STANDARDIZATION OF SOLUTIONS OF RADIONUCLIDES. Merritt, Janet S.; Taylor, J. G. V. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 48p. Dep. CFSTI. CAN $1.50.

A gravimetric sampling method based on a small polyethylene ampoule as the pycnometer is described. The method affords speed and simplicity in sampling. It was tested by radioactivity determinations on samples prepared from a master solution of ^{60}Co and from dilutions; the tests show it to be precise within ±0.02%. Sources of error are discussed. The performance of the $4\pi\gamma$ ionization chamber used for the radioactivity measurements is described in an appendix together with the associated circuits. (auth)

27885 (AERE-M-1845) THE DETERMINATION OF ^{45}Ca IN URINE BY LIQUID SCINTILLATION COUNTING. Sandalls, F. J. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1967. 12p. Dep. CFSTI. UK 1s. 9d.

A simple method is described for the determination of calcium-45 in urine in which a buffered solution of ammonium oxalate is added to 50 ml of urine to produce a precipitate of calcium oxalate. This precipitate is dissolved in acid, reprecipitated, and counted as a gel suspension in a liquid scintillation counter. The overall recovery of calcium-45 is quantitative and, with a Packard Tricarb 3214 liquid scintillation spectrometer, a counting efficiency of 90% is achieved. The counting efficiency is insensitive to quite large variations in the weight of oxalate precipitate. The minimum level of detection is 22 pCi/1400 ml of urine, which is lower than the investigation level by a factor of greater than 10^2. (auth)

27886 (AERE-M-1886) SPECTROPHOTOMETRIC ANALYSIS OF THIN ANTIMONY-ARSENIC ALLOY FILMS. Tomlinson, L. (Atomic Energy Research Establishment, Harwell (England)). May 1967. 10p. Dep. CFSTI. UK 1s. 9d.

A spectrophotometric method is described for determining antimony and arsenic (without separation) in thin antimony-arsenic alloy films containing 0 to 50 μg of each element. Antimony is determined by the iodine-ascorbic acid method, and arsenic by the molybdenum blue method. (auth)

27887 (AERE-R-4850) DETERMINATION OF OYGEN IN FLUORIDES AND REFRACTORIES BY INERT GAS FUSION. Greenfield, B. F.; Hyde, K. R. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 10p. Dep. CFSTI. UK 1s. 9d.

An apparatus for the rapid determination of oxygen in fluorides by inert gas fusion is described. The sample is reacted with carbon at a high temperature. The carbon monoxide is removed in a stream of high purity argon, oxidized to carbon dioxide, which is collected in a trap at liquid nitrogen temperature, allowed to warm to room temperature, and determined by measurement of its volume and pressure. The accuracy of the method has been established by using a uranium dioxide standard. Results are given for various types of fluoride melts, refractory nitrides, and carbon nitrides. (auth)

27888 (BLG-408) PLUTONIUM AND AMERICIUM FECAL ANALYSIS. Valentin, N.; Weyers, C.; Luysterborg, J. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Apr. 1966. 23p. Dep.

A method for determining the amount of plutonium and/or americium in fecal samples is described. After wet ashing of the sample and complete dissolution of the ashes, the resulting solution is transferred to a volumetric flask and the volume adjusted to one liter. Several fractions of the solution can be analyzed by three different analytical procedures: rapid determination of Pu and/or Am; selective determination of Pu; or selective determination of Am. All three methods give a recovery mean above 80%. Whereas the sensitivity of the first procedure is of the order of 2 dpm, the detection level of the selective determinations is 0.06 dpm. (auth)

27889 (CEA-R-3145) MICRODETERMINATION RAPIDE DE L'IODE DANS LES EAUX. (Rapid-Micro-Determination of Iodine in Water). Godin, Jean-Marie; Archimbaud, Michelle (Commissariat a l'Energie Atomique, Pierrelatte (France)). Mar. 1967. 18p. (In French). Dep.

A method is described for detecting one microgram of iodine per liter of water. After having tested manually volumetric and colorimetric methods, a kinetic method was selected. Reduction of arsenous oxide by ceric sulfate is catalyzed by the presence of small quantities of iodine. Failure of manual tests led to the adoption of a Technicon autoanalyzer for carrying out the determination; this improves the reproducibility of the method and gives a sensitivity of about 1 microgram of iodine per liter with an accuracy of ±15%. (auth)

27890 (EUR-3271.d) RADIOCHEMISCHE BESTIMMUNG DER SPALTPRODUKTABGABE VON BESCHICHTETEN BRENNSTOFFPARTIKELN NACH DER REAKTOR-BESTRAHLUNG. (Radiochemical Determination of Fission Product Release From Coated Fuel Particles After In-Pile Irradiation). Riedel, H. J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Feb. 1967. 14p. (In German). Dep.

Under a post-irradiation test program on the behavior of various types of particles as a function of operating temperature, burnup, etc., a radiochemical study was made of the fission product distribution in graphite surrounding coated fuel particles. For the analytic separation and assay of the fission elements distillation, precipitation, liquid-extraction, and ion-exchange techniques were used. The methods are briefly described. In this way 12 fission nuclides can be determined. A notably high mobility was observed for the fission elements Ba, Sr, and Y. The release of other fission products with a higher fission yield was considerably lower. Some of the parameters affecting fission product release are discussed. (P.C.H.)

27891 (EUR-3292.i) ANALISI DELLE MISCELE ORGANICHE SOSTITUTE DEI TERFENILI. (Analysis of Organic Mixtures Substitutes for Terphenyls). Versino, B.; Geiss, F.; Poleman, J. A. M.; Vissers, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Feb. 2, 1967. 53p. (In Italian). Dep.

Analytical methods suitable for the characterization of substitute organic mixtures for terphenyls before and after radiopyrolytic treatments are reviewed. The methods include gas chromatography, thin-layer chromatography, infrared and ultraviolet spectroscopy, microdistillation, C/H ratio, and molecular weight. The organic mixtures examined were: HB-40, OMP-H, Thermip-P2, AKP/m, Marlotherm, D.O.M., OMB, and OS-124. A survey of the principal physical properties is also given. (auth)

27892 (MSAR-67-80) DEVELOPMENT OF TECHNIQUES FOR THE MEASUREMENT OF IMPURITIES IN SODIUM. Quarterly Progress Report, January-March 1967. (MSA Research Corp., Evans City, Pa.). May 1967. Contract AT(11-1)-765. 16p. Dep. CFSTI.

Developments in the surface tension method for determining impurities in sodium are described. Various design aspects of a new surface tension apparatus are illustrated. The new apparatus will permit precise sodium surface tension measurements under various oxygen concentrations. (P.C.H.)

27893 (NBL-237) ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1965 THROUGH JUNE 1966. (New Brunswick Lab. (AEC), N. J.). Feb. 1967. 102p. Dep. CFSTI.

Results are reported on: spectrophotometric determination of Mo and W in B, ^{10}B scrap recovery, dissolution of powdered B for flame spectroscopic analysis, determination of some impurities in B using a direct-reading spectrograph, determination of B in stainless steel-boron alloys, determination of Na in B by fast-neutron activation, adaptation of dual-grating spectrograph to a direct reading instrument, design of transistorized high-sensitivity coulometric titrator, determination of rare earths in ore residues, analysis of uranium solutions by atomic absorption spectrometry, calibration of uranium foils by $\alpha-\gamma$ coincidence method, mass spectrometric isotopic analysis of U, preparation of spectrographic standards for Be, storage and shipment of $Pu(NO_3)_4$ standard solutions, spectrochemical determination of impurities in Pu, spectrophotometric determination of Fe in Pu, effect of ion exchange resin on potentiometric determination of Pu, preparation of U-Pu-Mo solutions, and spectrophotometric determination of Mo in U-Pu-Mo and U-Mo solutions. (M.C.G.)

27894 (ORNL-P-3051) ANALYSIS OF SOLUTION AND RADIOACTIVE SAMPLES BY SPARK SOURCE MASS SPECTROMETRY. [PART] II. Carter, J. A. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 7p. (CONF-670420-1). Dep. CFSTI.

From MS-7 Users Meeting, White Plains, N. Y.

Experience in the use of spark source mass spectrometry for the analysis of radioactive materials is discussed. Analyses were made on Cr-Tc alloys for trace impurities and Tc concentration, uranium metal and uranium as the oxide, sulfide, phosphide, and nitride, Re-W thermocouple wires, radioactive solutions. Data are tabulated. (P.C.H.)

27895 (SZS-1/1967) RADIOCHEMISCHE BESTIMMUNG VON ^{137}Cs IN WASSER, FALLOUT, FILTERN, PFLANZEN UND NAHRUNGSMITTELN. (Radiochemical Determination of ^{137}Cs in Water, Fallout, Filters, Plants, and Food). Rehak, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Feb. 1967. 21p. (In German). Dep.

A method is described for determining ^{137}Cs in water, fallout, and biological materials. The essential stages of the method are ion exchange on ammonium molybdophosphate and precipitation of the cesium as chloroplatinate. The separation of ^{90}Sr from the same sample is possible. (auth)

27896 (TRG-Report-1309) X-RAY DIFFRACTOMETRY TECHNIQUES FOR CERAMIC FUELS. Bremner, W. B.; White, D. B. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Aug. 5, 1966. 12p. Dep. CFSTI. UK 3s. 0d.

The design of suitable diffractometer sample containment involving a nitrogen/argon two-gas system is described. Various mounting techniques are discussed and their relative merits are outlined. It was found that a resin mounting technique was most suitable for diffraction line profile measurements when (U Pu)O_2 was being examined. Analysis of small amounts of sesquicarbide and oxide phases in (U Pu)C was carried out using a paraffin wax binder, followed by low-pressure pelleting. Examples of the application of these and other diffractometry techniques are given. (auth)

27897 (USNRDL-TR-67-46) A COMPUTER PROGRAM FOR IDENTIFYING AND MEASURING COMPONENTS IN A MIXTURE OF GAMMA-EMITTING RADIONUCLIDES. Pestaner, J. F.; Love, D. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Mar. 1, 1967. Contract AT(49-7)-2886. 48p. Dep. CFSTI.

A computer program was developed for the analysis of the components of a gamma pulse-height distribution composed of a mixture of two or more gamma-emitting radionuclides. The program consists of identifying the largest gamma photopeak and matching its energy with the largest photopeak of each of the individual radionuclides that compose the mixture, subtracting enough of the individual radionuclide gamma pulse-height distribution from the mixture so that the photopeak in question is reduced by a certain small percentage, and continuing the incremental subtraction process until the photopeaks in the mixture can no longer be identified. This computer program has several advantages over other computer programs that have been developed to do the equivalent of a radiochemical analysis on a mixture of radionuclides. It will be especially useful in analyzing the large number of low activity mixtures of radionuclides that are to be made in the program to determine the physical-chemical species of the radionuclide debris produced by under-water nuclear explosions. (auth)

27898 (NP-tr-1309, pp 21-8) SPECTROCHEMICAL ANALYSIS OF H_2O-D_2O MIXTURES BY MEANS OF BAND SPECTRA. Dunken, H.; Mikkeleit, W.; Haucke, G. Translated from Glas. Hem. Drus. Beograd, 28: No. 8-9, 429-38 (1963).

An attempt was made to establish spectroscopically the smallest concentration change of D_2O in water of natural composition so that this method can be applied to processes where such a concentration change occurs. The reproducibility obtained was ±0.0006 mol % D_2O at the concentration of natural water, corresponding to a relative error of 4%. (M.C.G.)

27899 RADIOMETRIC ISOTOPIC ANALYSIS OF ^{233}U-^{235}U MIXTURES. Merz, E. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 9: 381-4(May 1967). (In German).

A radiometric burnup measurement procedure is described, which allows a reliable isotopic abundance analysis of $^{233}U-^{235}U$ mixtures. Measuring the thermal-neutron-induced radioactivity ratios of two different fission product nuclides that show considerable differences in fission yields for the two uranium isotopes and comparing them with pure ^{233}U and ^{235}U standards irradiated under identical conditions, the unknown content of ^{233}U and ^{235}U in the sample may be evaluated. Two different fission-yield ratios are applicable for this purpose, $^{103}Ru/^{89}Sr$ and $^{103}Ru/^{131}I$. In addition the amount of ^{239}U present in the samples can be determined by activation analysis of the (n,γ)-induced ^{239}Np activity. (auth)

27900 SPECTROPHOTOMETRIC DETERMINATION OF FLUORINE WITH THE PAC-Th COMPLEX. Shimoishi, Yasuaki (Okayama Univ., Japan); Hayami, Tadashi. Bull. Chem. Soc. Jap., 40: 1139-41(May 1967).

A method of determining micro amounts of fluorine, based on the bleaching of the thorium complex of 2-(1,8-dihydroxy-3, 6-disulfo-2-naphthylazo)-phenoxyacetic acid (PAC) by fluoride ions, which are strongly coordinated to the thorium in the complex and thus liberate the free PAC, is given. The complex is composed of thorium and PAC in a 1:1 molar ratio. PAC has an absorption maximum at 525 mμ, while the thorium complex shows a maximum at 555 mμ. The determination is based on the decrease in the absorbance at 610 mμ. Beer's law holds up to 30 μg fluoride ions per 25 ml. The optimum pH range is from 2.5 to 3.5. The apparent molar extinction coefficient is calculated to be 20,000. (auth)

27901 POLAROGRAPHIC BEHAVIOR OF URANIUM(VI) IN MALONIC ACID MEDIA. DETERMINATION OF URANIUM IN PLUTONIUM. Plock, C. E.; Miner, F. J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chim. Acta, 38: 553-62(Aug. 1967).

The polarographic behavior of the uranium-malonate complex was investigated over the pH range of 1.1 to 6.5. A reversible, one-electron wave was obtained. Below pH 4.9, the rate of disproportionation was nearly instantaneous and gave rise to a pseudo uranium(VI)-uranium(IV) reduction. Above pH 4.8 the concentration of uranium(V) was stable with respect to disproportionation. The half-wave potential was pH-dependent below pH 4.9, but it was independent of the malonate concentration above 0.1 M. The diffusion current constant was 2.78 for the conditions described. A procedure for the determination of uranium in plutonium was developed for uranium concentrations greater than 225 ppM. Of 21 common impurities found in plutonium metal, only Cu, Fe, Pb, Sb, and Ti caused significant interference; titanium can be removed by ion exchange, and the other interferences by mercury cathode electrolysis. (auth)

27902 SPECTROPHOTOMETRIC STUDY ON THE THORIUM COMPLEX OF o-CARBOXYPHENYL-AZO-CHROMOTROPIC ACID. Toei, Kyoji; Miyata, Haruo; Harada, Takuji (Okayama Univ., Japan). Bull. Chem. Soc. Jap., 40: 1141-5(May 1967).

o-Carboxyphenyl-azo-chromotropic acid was synthesized as a colorimetric reagent for thorium. The acid dissociation constants of the reagent were determined spectrophotometrically at 25°C and $\mu = 0.1$ ($NaClO_4$). The pK_1 (for the dissociation of the carboxyl group) and the pK_2 (for the dissociation of the naphtholic hydroxyl groups) were 3.20 and 10.17, respectively. The reagent formed a violet 1:1 complex with thorium, showing an absorption maximum at 565 mμ in an acidic solution. The apparent stability

constant of the thorium complex was measured spectrophotometrically. (auth)

27903 SPECTROPHOTOMETRIC STUDY ON THE THORIUM COMPLEX OF o-HYDROXYPHENYL-AZO-CHROMOTROPIC ACID. Toei, Kyoji; Miyata, Haruo; Nakashima, Susumu; Kiguchi, Sachiaki (Okayama Univ., Japan). Bull. Chem. Soc. Jap., 40: 1145-7(May 1967).

o-Hydroxyphenyl-azo-chromotropic acid was used as a colorimetric reagent for thorium. The acid dissociation constants of the reagent were determined by the pH titration method. The pK_1 (for the dissociation of the phenolic hydroxyl group) and pK_2 (for that of the naphtholic hydroxyl group) were found to be 7.60 and 10.60, respectively, at 25°C and $\mu = 0.1$. The reagent forms a violet 1:1 complex in an acidic solution, and its apparent stability constant was measured spectrophotometrically. (auth)

27904 THE SPECTROPHOTOMETRIC DETERMINATION OF SCANDIUM(III) WITH CHROMAZUROL S. Ishida, Ryoei; Hasegawa, Norio (Hokkaido Univ. of Education, Japan). Bull. Chem. Soc. Jap., 40: 1153-8(May 1967).

Chrome azurol S reacts with scandium(III) in a weakly acidic medium to form one of two kinds of complexes according to the pH value of the medium. Their compositions were confirmed; one had a 1:2 combining ratio of scandium(III) and chrome azurol S at pH 5.2 or higher, and the other, a 1:1 ratio at pH below 4.0. The color development of the 1:2 complex was more sensitive than the other. Therefore, it was applied to the determination of scandium(III). Several conditions for the color development were investigated, a calibration curve was made under the optimum conditions, and the influences of coexisting ions were investigated. The maximum absorption wavelength of the complex was 550 mμ against the reagent blank. The optimum pH for the color development was about 5.6. By adding a reagent in an amount four times the scandium concentration, the maximum color intensity was given. The color intensity decreased gradually during the first 1.5 hr, and then remained constant for several hours. A linear relationship between the absorbance and the scandium concentration was obtained in the concentration range from 4 to 27 μg per 10 ml. The value of the molar extinction coefficient of the complex at 550 mμ was 27,000, and the sensitivity of the color reaction was 0.0017 $\mu g/cm^2$ for $\log I_0/I = 0.001$. The formation constant, K, of the complex was calculated to be 9.5×10^{11} under these conditions. Anions such as fluoride, phosphate, oxalate, tartrate, citrate, and EDTA interfered with the color development of the complex. Cations such as Al(III), Be(II), U(VI), Fe(II), Th(IV), Cu(II), Y(III), Fe(III), Zr(IV), and W(VI) also interfered. (auth)

27905 USE OF GAMMA-RAY EXCITED X-RAY SOURCES IN X-RAY FLUORESCENCE ANALYSIS. Watt, J. S. (Australian Atomic Energy Commission, Sutherland, New South Wales). Int. J. Appl. Radiat. Isotop., 18: 383-91(1967).

Gamma excited x-ray sources yield essentially monoenergetic x-rays whose energy may be chosen. High sensitivity of analysis and determination of coating weights results from use of these sources in conjunction with non-dispersive x-ray fluorescence techniques. ^{241}Am, ^{109}Cd, ^{155}Eu, ^{153}Gd, and ^{145}Sm were found to be suitable radioisotope sources with sufficiently low levels of impurities. A comparison was made of the characteristics of various geometries of source, sample, and detector, and combination of geometry with specific radioisotope sources is discussed. Results for eleven applications are given. The lower limit of detection of the minor constituent in two-component samples was about 150 ppM, and for coatings several $\mu g/cm^2$. Calculations are outlined and are shown to agree well with experiment. (auth)

27906 NUCLEAR-DETECTION METHOD FOR SULFUR IN THIN FILMS. Wolicki, E. A.; Knudson, A. R. (Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop., 18: 429-33(1967).

A method is described for identifying the presence of sulfur in thin films on coins through the use of the $^{32}S(d, p)^{33}S$ reaction. A sample film was bombarded with a 2.0-MeV deuteron beam from a Van de Graaff accelerator, and a high resolution solid-state detector, located at 135° with respect to the incident beam direction, was used to detect the protons emitted from the target. The method is non-consuming and is simple and sensitive; sulfur films with surface densities of 10^{-7} g/cm^2 are estimated to be easily identifiable. The area of the sample film bombarded by the beam was approximately 0.5 mm^2. No attempts were made to determine the ultimate sensitivity of the method. The technique described should prove useful also for other combinations of thin film and backing materials. For each case, however, choice of the appropriate nuclear reaction will depend on considerations of interfering radiation from the backing materials and from likely contaminants. (auth)

27907 ACTIVATION ANALYSIS OF TUNGSTEN AND ARSENIC IN V_2O_5 BY COINCIDENCE SPECTROMETRY. Adams, F.; Hoste, J. (Ghent Univ.). Acta Chim. Acad. Sci. Hung., 52: 115-22(1967).

The 0.550-MeV gamma radiation of ^{76}As interferes with the nondestructive direct spectrometric determination of the W and As content of purified vanadium pentoxide. To eliminate this difficulty, a method was developed for determination of the elements in the presence of each other by gamma–gamma coincidence techniques. The determination of ^{187}W is rendered possible by measurement of the 134 KeV and 72 KeV cascade photons, and that of ^{76}As by the measurement of the 0.55 and 0.65 MeV cascade gamma photons. (auth)

27908 INVESTIGATIONS ON THE EMISSION OF POSITIVE SECONDARY IONS FROM SOLID TARGETS. THE USEFULNESS OF ION-BOMBARDMENT ION SOURCES IN MASS SPECTROSCOPY. Beske, Horst E. (Johannes-Gutenberg-Univ., Mainz). Z. Naturforsch., 22a: 459-67(Apr. 1967). (In German).

If solids are bombarded by ions, positive secondary ions (SI) of all elements of the target material are emitted. The mass analysis of these SI permits conclusions to be drawn about the composition of the target material. An arrangement based on this kind of ion production is called an ion–bombardment ion source. The suitability of this ion source for quantitative analysis of solids by mass spectrometry was investigated. For this purpose the SI yield γ^+ of 27 elements was measured at constant bombardment conditions (12 keV A^+-ions, 45° incidence). γ^+ is approximately 1% for 10 elements: Si, Mn, Fe, Co, Ni, Rh, Ta, W, Os, and U. Aluminum showed the largest, gold the smallest SI yield. Yields differ by a factor of 1000 for different elements. The influence of the ionization energy on the SI yield is discussed. The yield is independent of the concentration in the range 0.02 to 20%. (auth)

27909 ORE ANALYSIS FOR THORIUM AND URANIUM BY DELAYED NEUTRONS. Lee, N. K.; Lin, S. C.; Chien, J. P.; Lee, Y. H. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 5: No. 1-2, 23-8(Dec. 1966).

The method of delayed neutrons was employed for determination of thorium and uranium in local ores. The pneumatic tube of THOR was used for irradiation. Cadmium ratios of thorium and uranium were measured by standard samples. Thorium and uranium contents in unknown samples were evaluated from the counts of delayed neutrons with and without cadmium covers during irradiation. The experimental time required for each sample was about 2½ min. The results agreed well with those obtained by the gamma spectrometry. (auth)

27910 DETERMINATION OF THORIUM CONTENT IN MONAZITE ORE BY GAMMA RAY SPECTRA. Lin, S. C.; Chien, J. P. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 5: No. 1-2, 29-32(Dec. 1966).

The gamma spectra of monazite samples were measured by a 3 in. × 3 in. NaI(Tl) scintillator and a 400-channel pulse-height analyzer. The 2.615-MeV characteristic gamma ray of the thorium daughter (Tl-208) was employed for quantitative determination. The results obtained were checked with another independent method, the method of delayed neutrons. (auth)

27911 DETERMINATION OF URANIUM IN SOILS BY PRECIPITATION WITH ORGANIC COPRECIPITATES. Akimova, T. G. Radiokhimiya, 9: 76-80(1967). (In Russian).

A method for concentration of U in soils with organic coprecipitates was developed. The U is coprecipitated in the form of complex salts of thiocyanate anions with Crystal Violet thiocyanate with subsequent luminescent determination of U by the addition method. The method makes it possible to concentrate U in heavy clay soils at concentrations of 0.5 mg of U in 1 g of soil on the average of 96%. (tr-auth)

27912 ABSOLUTE MEASUREMENTS OF α-RADIOACTIVE ISOTOPES BY MEANS OF NUCLEAR PHOTOEMULSIONS. Korobkov, V. I.; Zaborenko, K. B.; Makarov, M. A. Radiokhimiya, 9: 140-2(1967). (In Russian).

The possibility of quantitative determination of α-radioactive isotopes by microautoradiographic methods and utilization of the statistical method of processing the results obtained by introduction of the isotopes in photoemulsions was shown. (tr-auth)

27913 ELECTROCAPILLARY METHOD OF INTRODUCING RADIOACTIVE ISOTOPES INTO NUCLEAR PHOTOEMULSION. Korobkov, V. I.; Chirin, N. A.; Zaborenko, K. B. Radiokhimiya, 9: 143-6(1967). (In Russian).

The method of electrocapillary filling for introduction of α-radioactive isotopes into nuclear photoemulsions was proposed. The comparatively high density of the material and the known character of the decay of the radioactive atoms make this method of introduction of interest for absolute measurement of α-radioactive isotopes using nuclear emulsions. (tr-auth)

27914 OXYSULFIDES OF PLUTONIUM. Marcon, Jean-Pierre (CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. C, 264: 1475-6(Apr. 24, 1967). (In French).

It is shown that there exist, in addition to the well-known Pu_2O_2S, two other oxysulfides of plutonium: PuOS (α) and $Pu_4O_4S_3$. The existence of a fourth oxysulfide, designated provisionally as PuOS (β), appears probable. (tr-auth)

27915 DETERMINATION OF LANTHANIDES BY SUBSTITUTION OF READILY POLAROGRAPHED METALS. Khasan, M. Z.; Sevryukov, N. N. (Patris Lumumba Univ. of Peoples Friendship, Moscow). Zh. Anal. Khim., 22: 713-17(May 1967). (In Russian).

The determination of lanthanides by the substitution of lead in their oxalates followed by the polarographic determination of lead ions was studied. It was found that all the lanthanides and scandium as well as their mixtures can be determined by this method within the range of concentrations from 5×10^{-4} to 5×10^{-3} M with an accuracy of ±5 to 7%. (auth)

27916 NEW REAGENTS FOR THE EXTRACTION-PHOTOMETRIC DETERMINATION OF PLUTONIUM(IV). Milyukova, M. S.; Savvin, S. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 22: 751-6(May 1967). (In Russian).

A study was made on the extraction of plutonium(IV) complexes with a number of reagents that are analogous to arsenazo III in their structure and contain different functional analytical groups. It was found that the compounds of plutonium with arsenazo-amino-ϵ-acid and arsenazo-2-methoxy-5-diethylsulfamic acid were quantitatively extracted from 0.1 M nitric acid solutions by butyl alcohol containing tribenzyl amine. The method can be used for the concentration and extraction-photometric determination of plutonium. (auth)

27917 FLUOROMETRIC DETERMINATION OF MICROAMOUNTS OF CERIUM IN PREPARATIONS OF THE RARE EARTH ELEMENTS. Poluektov, N. S.; Kirillov, A. I.; Tishchenko, M. A.; Zelyukova, Yu. V. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 22: 707-12(May 1967). (In Russian).

A method was developed for the fluorometric determination of Ce^{3+} by the fluorescence band with a maximum at 350 nm. The fluorescence is excited by the radiation of a mercury tube with the wave length of 265.2 nm. The effects of certain cations and acids were studied. A strong quenching effect of NO_3^-, Fe^{3+}, and Ce(IV) ions was observed. A method was developed for the determination of Ce^{3+} in preparations of the rare earths with a sensitivity of 1×10^{-4}%. (auth)

27918 OXYGEN DETERMINATION IN STEEL BY ACTIVATION ANALYSIS. A RAPID NON-DESTRUCTIVE METHOD. Perdijon, J. (Ingenieur Civil des Mines, Grenoble, France). Atomwirtschaft, 12: 131-3(Mar. 1967). (In German).

The oxygen content of steel is an important contaminant that must be determined very rapidly and very accurately. Only activation analysis gives, simultaneously, sufficient rapidity and sensitivity as a nondestructive method. By the introduction of neutron generators it is suitable as an industrial routine method with relatively low cost. Operational experiences and methods were reported on the basis of two years experience with an apparatus specially developed for O_2 determination in steel. (tr-auth)

27919 EXTRACTION SEPARATION WITH THE INTRODUCTION OF AN INTERMEDIATE ELEMENT. SEPARATION OF TIN AND ZINC BY MEANS OF ISOBUTYLDIANTIPYRYLMETHANE. Zhivopistsev, V. P.; Minina, V. S.; Petrov, B. I. (Gorky State Univ., USSR). Zh. Anal. Khim., 22: 495-9(Apr. 1967). (In Russian).

A study was made on the extraction with chloroform of a large number of elements as their metallothiocyanate complexes with isobutylmethylenediantipyrine. By their extractability the elements were arranged in a certain thiocyanate series. The difference in the extraction capacity of elements was used for the development of the method of an intermediate element which permits an increase in the selectivity of the separation and determination of elements in a number of cases. Highly selective methods for separating and determining tin and zinc were developed. Tin was determined in samples containing Pb, Bi, Sb, Cu, Zn, Ca, Zr, Th, Ti, Fe, Co, Ni, Cr, Mo, W, U, V, rare earths and others (more than 60 elements). The determination of zinc is possible in the presence of Cd, Fe, Cu, V, Sb, Bi, Mo, and other elements. (auth)

27920 DETERMINATION OF CALCIUM IN A WIDE RANGE OF CONCENTRATIONS IN THE PRESENCE OF EUROPIUM. Bukreev, Yu. F.; Zolotavin, V. L.; Muzgin, V. N.; Ignat'eva, N. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Anal. Khim., 22: 514-17(Apr. 1967). (In Russian).

A study was made on the effects of nitric, hydrochloric, perchloric, and phosphoric acids and also europium on the results of the emission and atomic-absorption flame photometric determination of calcium in a wide range of concentrations. It was found that the best method for calcium determination under such conditions is the atomic-absorption flame photometric method. A method was developed for determining calcium in the presence of europium by the atomic-absorption spectra of calcium. The relative experimental error of calcium determination within the range from 30 to 95% of CaO was not more than 3%. The method was also used for the study of the composition of solid solutions formed by CaO and EuO. (auth)

27921 PHOTOMETRIC DETERMINATION OF MOLYBDENUM BY MEANS OF SULPHOCHLOROPHENOL S. Elinson, S. V.; Savvin, S. B.; Nezhnova, T. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 22: 531-5(Apr. 1967). (In Russian).

Sulphochlorophenol S (4,5-dihydroxy-3-[(4-chloro-2-hydroxy-3-sulfophenyl)azo]2,7-naphthalenedisulfonic acid) was studied as a reagent for molybdenum. A blue complex compound with the maximum absorption at 600 nm was formed at pH 0.5 to 3.0. In order to obtain the maximum selectivity the determination was carried out in 0.25N H_2SO_4. The optical density was measured at 650 nm. The molar extinction coefficient of the complex compound is about 13,500. A method was developed for determining more than 0.05% of molybdenum in alloys containing U, W, Re, Zr, Sn, Fe, Co, Ni, Cu, and other elements. The accuracy of the method for the determination of tenth parts of 1% is ±5%. Niobium and anions that form complexes with molybdenum interfered with the determination. (auth)

27922 ANALYSIS OF NUCLEIC ACID CONTENT OF TETRAHYMENA BY MEANS OF INDUCED RADIOACTIVITY. Akaboshi, Mitsuhiko; Waki, Asako (Kyoto Univ.). Dobutsugaku Zasshi, 75: 183-6(June 1966). (In Japanese).

Commercially available salmon sperm DNA was activated by exposure to a neutron flux of approximately 4×10^{12} n/cm^2/sec for an hour at the pneumatic tube of the reactor of Kyoto University. Immediately after activation, samples emitted β and γ rays, due to ^{32}P and ^{24}Na, respectively, but after 7 days' cooling, only β rays from ^{32}P were detectable. The counts of β rays then gave the amount of DNA-P. Sensitivity of this method under the conditions described above was found to be 0.5 μg DNA. Contents of DNA and RNA in Tetrahymena pyriformis W. were determined by this method. They were 2.77 to 3.44×10^{-6} μg P/cell and 41.9 to 47.8×10^{-6} μg P/cell, respectively. In this case, DNA was separated by DNase from nucleoprotein and residual proteins were removed by precipitation with formic acid. To improve the sensitivity of this activation analysis of nucleic acids in the living cell, it is necessary to minimize the loss of nucleic acids or cells from the small amounts of samples in the process of extraction. (NSA of Japan)

27923 DETERMINATION BY INSTRUMENTAL ACTIVATION ANALYSIS OF TRACES OF CHLORINE IN ORGANIC SUBSTANCES WITH NUCLEAR APPLICATION. Orvini, E. (Univ., Pavia, Italy). Energ. Nucl. (Milan), 14: 249-51(Apr. 1967). (In French).

The determination by instrumental neutron activation analysis of chlorine impurities was applied to organic materials such as polyethylene, delrin, polystyrene, nylon, and terphenyl. The sensitivity of the method of determination is about 0.05 ppM. The precision is in the range ±3 to ±10% for chlorine contents in the range of 0.05 to several ppM. (tr-auth)

27924 COUNTING OF β-EMITTING ISOTOPES IN SPECIMENS OF BIOLOGICAL ORIGIN BY LIQUID SCINTILLATORS. Szilagyi, Erzsebet; Fodor, Piroska. Atomtech. Tajek., 9: 631-7 (1966). (In Hungarian).

The activity of β emitters, such as ^3H, ^{14}C, ^{35}S, ^{45}Ca, and ^{32}P, widely used in biological studies, is usually counted by means of liquid scintillators. Preparation of biological samples for counting often presents problems because the samples are not soluble in many cases and must therefore be used in the form of emulsions or suspensions, which may be stabilized by gels. The presence of dyes results in interference in the measurements because they absorb photons and disturb the prevailing linear correlations. Diluents and extinction agents also present problems. Organic compounds containing tritium may be ignited to form water, while the compounds labeled with ^{14}C yield CO_2. The aqueous samples may be counted conveniently; the CO_2 gas may be absorbed by barium hydroxide but it may be preferable to use a gas-filled counter. Water-soluble specimens may be mixed with the scintillator solution by adding ethyl or methyl alcohol; however, this reduces the efficiency of counting. (TTT)

27925 SPECTROSCOPIC ULTRAMICROANALYSIS WITH A LASER. Rosan, Robert C.; Healy, Mary K.; McNary, William

F. Jr. (Univ. Medical Center, Mass.). Science, 142: 236-7 (Oct. 11, 1963).

A versatile new method was used for atomic analysis of biological materials under direct microscopic control. In principle, the intense energy from a ruby laser was focused through a microscope upon a previously selected target. The sample was vaporized by the laser at a temperature of about 5000°K and the resultant activated atomic gases were sparked between carbon electrodes at 1000 v, thereby raising the energy of the gases to spectral emissive levels. Resultant light was relayed to a spectrograph for photoelectric or photographic recording. The entire process took 0.01 sec. The technique was applicable to living or resected material, sectioned or whole. Spectra of brain, pancreas, elastin, and calculi that reveal the presence of Mn, Fe, Be, Cu, Zn, and Ca in these tissues are given. Certain soft biological materials, such as ligamentum nuchae elastin, were analyzed even when sectioned as thin as 12 μ. The analytical limits went as far as 10^{-10} mole for some biologically important cations. More sensitive detection systems may be directly superimposed. Although this method was not amenable to quantitative analysis, careful experimental techniques permitted estimation of relative concentrations to ±20%. The illustrated spectra showed that the simplest application was determination of the changes in the ratio of one or more elements to some internal base. (BBB)

27926 THE APPLICATION OF LASER SPECTROSCOPY FOR THE QUALITATIVE AND QUANTITATIVE ANALYSES OF THE INORGANIC COMPONENTS OF CALCIFIED TISSUES. Goldman, Henry M.; Ruben, Morris P.; Sherman, Donald (Boston Univ.). Oral Surg., Oral Med., Oral Pathol., 17: 102-3(Jan. 1964).

A new method for analysis of the inorganic composition of calcified tissues is presented. The characteristics of laser radiation, particularly its ability to vaporize materials, are discussed. In the technique employed in the pilot investigation, a pulsed ruby laser was used to vaporize minute amounts of calcified tissues for spectrographic analysis. The material was vaporized by superheating with simultaneous emission of a spectrum. The laser beam produced a 50-μ crater (50 μ in dia by 50 μ in depth) in the analyzed material. A table of representative analytical composition obtained by laser spectroscopy of supra- and subgingival calculi and mandibular cortical bone is presented. Data on content of Mg, Al, Si, Ca, P, Fe, Cu, and Zn in each of these components are given. (TSS)

27927 YADERNO-FIZICHESKIE METODY KONTROLYA VESHCHESTVENNOGO SOSTAVA. YADERNYE REAKTSII I AKTIVATSIONNYI ANALIZ. (Nuclear-Physical Methods of Material Composition Control. Nuclear Reactions and Activation Analysis). Plaksin, I. N.; Starchik, L. P. Moscow, Izdatel'stvo Nauka, 1966. 204p.

The rapidly developing trend of instrumental analysis—nuclear physical control methods is considered. The use of nuclear reactions with charged particles, neutrons, and γ-quanta and the subsequent activity for determination of composition of ores and their processing products are examined. (tr-auth)

27928 OBRAZTSOVYE ISTOCHNIKI IONIZIRUYUSHCHIKH IZLUCHENII. (Standard Sources of Ionizing Radiations). Dorofeev, G. A.; Inikhov, G. N. [Moscow], Atomizdat, 1967. 128p.

Procedures for testing and calibration of dosimetric and radiometric devices requiring knowledge of the technical characteristics of the standard sources used are reviewed. Construction of standard α, β, γ, and neutron sources is also considered. (J.S.R.)

27929 EKONOMICHESKAYA EFFEKTIVNNOST' PRIMENENIYA IZOTOPOV V METALLURGII. (Economics of Isotope Tracer Applications in Metallurgy). Mikheev, G. F. Moscow, Izdatel'stvo Metallurgiya, 1965. 128p.

Economics of tracer techniques for automation of controls and adjustments of industrial processes and technological improvements in metallurgy are reported. Many examples confirm efficiency of this technique for increased production and improved quality. Uses in metallography and physics of metals and in metallurgy were examined. (tr-auth)

27930 PRIMENENIE MOLEKULYARNOI SPEKTROSKOPII V KHIMII. Sbornik Dokladov na III Sibirskom Sobeshchanii po Spektroskopii, Sostoyavshemsya v Krasnoyarske v Kontse 1964 g. (Use of Molecular Spectroscopy in Chemistry. Third Siberian Conference on Spectroscopy held in Krasnoyarsk, Siberia, Dec. 1964). Korshunov, A. V. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 271p. (CONF-641223).

The 84 papers presented at the Third Siberian Conference on Spectroscopy held in Krasnoyarsk Siberia at the end of Dec. 1964 are compiled. Topics discussed are: calculation of spectral and other molecular characteristics; organic compounds and their complexes; organic and complex compounds of elements; high-molecular-weight compounds; biological objects; intermolecular interactions; crystals and phase transitions; questions of chemical kinetics and reaction capacities; and adsorption and catalysis. (J.S.R.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 27891, 28021, 28028, 28722, 28780, and 29969.

27931 (AD-651562) RARE EARTHS, IV, DISSOCIATION ENERGIES OF THE GASEOUS MONOXIDES OF THE RARE EARTHS. Technical Report No. 1. Ames, L. L.; Walsh, P. N.; White, David (Pennsylvania Univ., Philadelphia. Dept. of Chemistry). May 1967. Contract ONR-N00014-67A-0216-0001. 37p.

The dissociation energy of the gaseous rare earth monoxides together with the closely related compounds ScO and YO have been determined from Knudsen effusion and mass spectrometric isomolecular oxygen-exchange reaction studies. It is shown that there is a double periodicity in the variation of the dissociation energies with atomic number and that these variations closely match those of the heats of sublimation of the rare earth metals. Assuming a common bound state for the monoxides, $M^{2+}O^{2-}$, it is shown that the variations in the dissociation energies in the lanthanide series correspond to the magnitude of the $4f^n \rightarrow 4f^{n-1}5d$ transitions of the divalent ions. (auth)

27932 (AFML-TR-66-420) CRYSTALLOGRAPHIC AND MAGNETIC INVESTIGATION OF THE RARE EARTH-COBALT COMPOUNDS R_2Co_{17}. Ostertag, Werner; Strnat, Karl; Hoffer, Gary I. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Dec. 1966. 45p.

A series of new compounds corresponding to the formula R_2Co_{17}, where R represents Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, Lu, and Y, has been prepared. The compounds Pr_2Co_{17}, Nd_2Co_{17}, Sm_2Co_{17}, Gd_2Co_{17}, and Tb_2Co_{17} crystallize rhombohedrally, isomorphous with Th_2Zn_{17} (space group $R\bar{3}m$), while Ho_2Co_{17}, Er_2Co_{17}, Tm_2Co_{17}, and Lu_2Co_{17} have the hexagonal Th_2Ni_{17}-type structure (space group $P6_3/mmc$). The diffraction patterns of Ce_2Co_{17}, Dy_2Co_{17}, and Y_2Co_{17} were interpreted on the basis of a coexistence of the hexagonal and the rhombohedral modifications. Quenching techniques showed that the hexagonal form is the modification stable at high temperatures. Except for Ce_2Co_{17} and Pr_2Co_{17}, the volume of one formula unit R_2Co_{17} decreases with the atomic number of the rare earth-elements as a result of the lanthanide contraction. Size considerations indicate that in Ce_2Co_{17}, cerium is tetravalent, and in Pr_2Co_{17}, praseodymium has an effective valency of 3.3. The structures, being intermediate between AB_5 and the hypothetical μ-phase, are discussed in terms of "infillings of kagomé nets in direct superposition." Magnetic measurements showed that about one-half of the R_2Co_{17} compounds are ferrimagnetic, while the rest are simple ferromagnets. The saturation moments and Curie temperatures of all the compounds listed above were determined. The saturation moment of Y_2Co_{17} is 27.2 Bohr magnetons per formula unit (fu), that of Lu_2Co_{17} is 27.6μ_B/fu, indicating a cobalt moment of approximately 1.61μ_B in the entire series. Substitution of Pr and Nd for R raises the saturation to 32.9μ_B/fu for Pr_2Co_{17} and 32.1μ_B/fu for Nd_2Co_{17}; all other lanthanides lower it. (The minimum is 7.4μ_B/fu for Ho_2Co_{17}.) Except for Sm_2Co_{17}, the values agree well with the concept that the cobalt moments couple antiparallel with the rare earth spin sublattice. For Ce and Pr, a valency larger than three and electron transfer from R to Co must be assumed. The Curie temperatures lie between 795 and 940°C. A possible explanation of the variation of T_c with the atomic number of R may be that two coupling mechanisms are active near the Curie point: direct Co–Co exchange and indirect exchange between R and Co via polarized conduction electrons. (auth)

27933 (IN-1076) D MATRIX: A COMPUTER PROGRAM FOR CALCULATING VALENCE FORCE COORDINATES IN TERMS OF ATOM DISPLACEMENTS OF A MOLECULE OR CRYSTAL. Boyter, J. K.; McMurry, H. L. (Idaho Nuclear Corp., Idaho Falls). May 1967. Contract AT(10-1)-1230. 46p. Dep. CFSTI.

A Fortran program written for the IBM-7040 which calculates the valence force coordinates of the valence force potential function in terms of the atom displacements, and mass adjusted displacements in a molecule or crystal is described. The input data are explained with illustrative applications given for propane and diamond in the Appendix. Two other test examples are also given. (auth)

27934 (IS-T-146) KINETICS OF THE VAPOR PHASE CHLORINATION OF NIOBIUM OXYTRICHLORIDE USING CARBONYL

CHLORIDE. Boesiger, Dwight David (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 106p. Dep. CFSTI.

Thesis.

The kinetics of the reaction of niobium oxytrichloride ($NbOCl_3$) with carbonyl chloride ($COCl_2$) were investigated. The effects of time, temperature, and the concentrations of $NbOCl_3$ and $COCl_2$ on the rate of conversion of $NbOCl_3$ were studied in pyrex batch reactors. The range of total initial reactor pressures used was approximately 0.5 to 3.0 atmospheres. The major reaction products detected were niobium pentachloride ($NbCl_5$) and carbon dioxide. The method of nonlinear estimation of parameters was used to examine postulated kinetic models using variable temperature kinetic data. An empirical rate expression of the form $(d[NbOCl_3]/dt) = -k[NbOCl_3]^m [COCl_2]^q$ was used to correlate the kinetic data obtained. The values of m and q believed to be most reliable were m = 0.85 and q = 1.14. The temperature dependency of k, assuming an Arrhenius form, was established directly by nonlinear estimation of parameters using all, variable temperature data. The value of k obtained for the above values of m and q is $k = 1.27 \times 10^6 \exp(-22{,}100/RT)$ where T is the absolute temperature in degrees kelvin and the units for the activation energy are calories per mole. The values of k are consistent with concentrations in moles per liter and time in seconds. The above expression applies only to temperatures between 360 and 450°C. (auth)

27935 (IS-T-151) HIGH TEMPERATURE CHEMISTRY OF HAFNIUM SULFIDES. Graham, Joseph (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 80p. Dep. CFSTI.

Thesis.

A systematic investigation was made of the solid phases in the hafnium–sulfur system. The solid phases Hf_2S and HfS were prepared and the structures determined by single crystal and powder x-ray diffraction. The bonding in these compounds is discussed, and symmetry, brittleness, electrical conductivity and Pauling bond numbers are correlated with the valence of the hafnium and sulfur atoms. In 1948 Rundle used delocalized, directional bonds of bond number 2/3 or 1/2 to describe the bonding in many transition metal-mono-carbides, -nitrides, and -oxides. This bonding description was extended to describe the bonding in Hf_2S and HfS and later to other MX and MX_{1-x} compounds where M is a IV B transition element and X is a V A or VI A element. The nonmetal atoms in these MX compounds are surrounded by a trigonal prism of metal atoms (in the TiP structure type by a trigonal prism or octahedron). It was suggested that the nonmetal atoms use d-orbitals to form bonding orbitals in this case. The valences of the nonmetal atoms in the sub-compounds MX_{1-x} are consistent with the use of s- and p-orbitals for the nitrides and oxides and d-orbitals with the other compounds discussed. In these compounds short metal–metal distances which may be non-bonding cause the calculated valences of the metal atoms to be unreasonably high. (auth)

27936 (IS-T-153) THE CRYSTAL STRUCTURE OF $Ni(PO_3C_6H_9)_5(ClO_4)_2$. Riedel, Ernest Frederic (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 40p. Dep. CFSTI.

Thesis.

The structure of $Ni(PO_3C_6H_9)_5(ClO_4)_2$, pentakis-2,8,9-trioxa-1-phosphaaclamantanenickel(II) perchlorate, has been determined by x-ray diffraction techniques. This compound crystallizes in the triclinic space group $P\bar{1}$ with cell parameters: $\underline{a} = 11.53 \pm 0.05$, $\underline{b} = 18.92 \pm 0.07$, $\underline{c} = 12.61 \pm 0.05$Å, $\alpha = 96.40 \pm 0.5$, $\beta = 103.40 \pm 0.6$, and $\gamma = 96.90 \pm 0.5°$. A total of 2300 reflections were observed and refined isotropically to give a final agreement factor of 15%. The central coordination about the nickel atom is trigonal bipyramid. The axial bond for the phosphorus atom was found to be shorter than the equatorial phosphorus atoms. The shortness of the axial Ni–P bonds suggests some $d\pi-d\pi$ bonding between the nickel and the phosphorus. Considerations of interatomic repulsions suggest that trigonal bipyramid is more stable than the tetragonal pyramid configuration for the molecule. (auth)

27937 (IS-T-165) KINETIC STUDIES OF THE OXIDATION OF TANTALUM CLUSTER IONS BY COBALT(III) COMPLEXES IN ACIDIC SOLUTION. Boone, Donald Joe (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 36p. Dep. CFSTI.

Thesis.

The rates of reaction between the tantalum cluster ion $(Ta_6Cl_{12})^{2+}$ and various cobalt(III) complexes in acidic solution have been measured. For every complex studied, the stoichiometry was found to be consistent with one-electron oxidation of the tantalum cluster ion according to the equation $(Ta_6Cl_{12})^{2+} + Co(III) = (Ta_6Cl_{12})^{3+} + Co(II)$. The rate law in each case is second order $-d[(Ta_6Cl_{12})^{2+}]/dt = k[(Ta_6Cl_{12})^{2+}][Co(III)]$. Activation parameters were evaluated for the reaction between cis-chloroaquotetraamminecobalt(III) ion ($[Co(NH_3)_4(OH_2)Cl]^{2+}$) and $(Ta_6Cl_{12})^{2+}$. The fact that no chlorine-36 was found in $(Ta_6Cl_{12})^{3+}$ after oxidation of $(Ta_6Cl_{12})^{2+}$ with cis-$[Co(NH_3)_4(OH_2)^{36}Cl]^{2+}$ indicates an outer sphere path for electron transfer is most probable. (auth)

27938 (K-L-6117-2) FUTURE USE OF FLUORINE AND FLUORIDES IN THE NUCLEAR INDUSTRY. Smiley, S. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [nd]. Contract W-7405-eng-26. 7p. (CONF-660907-11). Dep. CFSTI.

From American Chemical Society Meeting, New York.

The preparation and use of inorganic fluorides and fluorine in the nuclear industry is reviewed. The use of fluorides, in particular UF_6, was initiated in the gaseous diffusion concept for separating ^{235}U from its naturally occurring isotopic mixture. The future of fluorides is also associated with the demand for enriched U, and thus for UF_6. (P.C.H.)

27939 (NP-16790) BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1967, Number 1, January–March 1967. Diamond, J. J. (ed.) (National Buraeau of Standards, Washington, D. C.). 93p. NBS, Washington, D. C. Free.

Over 900 references are presented under the headings: devices for achieving temperatures above 1500°C, devices for measuring and controlling temperatures above 1500°C, devices for physical measurements at temperatures above 1000°C, properties below 1000°C of materials that melt above 1500°C, properties above 1000°C of materials that melt above 1500°C, properties above 1000°C of materials that melt below 1500°C, phase equilibria, reactions at temperatures above 1000°C, and books. (M.C.G.)

27940 (ORNL-TM-1724) ELECTRON CAPTURE BY HYDROGEN HALIDES AND THEIR DEUTERATED ANALOGUES. Dickson, H. W.; Christophorou, L. G.; Compton, R. N. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 87p. Dep. CFSTI.

Thesis. Submitted by H. W. Dickson to Univ. of Tennessee, Knoxville.

The swarm beam method which combines information from electron swarm and electron beam experiments to establish an independent energy scale calibration and allows the determination of capture cross sections as a function of electron energy has been employed to study the electron capture processes in HX and DX (X = halogen) molecules. Previous swarm and beam studies have suggested that the only negative ions formed when low-energy electrons interact with HX molecules are X^-. The present results strongly suggest that in addition to Cl^- and Br^-, other negative ions are formed in HCl, DCl, HBr, and DBr at very low electron energies. The low-energy attachment rates are independent of the carrier gas pressure (200 to 800 torr), but preliminary data suggest that they increase linearly with the sample gas pressure in the case of DCl. The Cl^-, Br^-, and I^- ions are the dominant ions observed in the mass spectrometer, although peaks of low intensity corresponding to Cl_2^-, HCl_2^-, DCl_2^-, Br_2^-, HBr_2^-, and DBr_2^- were observed at zero electron energy. An analysis of the low-energy process revealed that the electron attachment probably occurs in a complex of HCl and that $(HCl)_2^-$ is likely to be the product. There is an isotope effect in the dissociative attachment of electrons to HX and DX in that the ratio of the capture cross sections is approximately equal to the square root of the inverse ratio of the reduced masses of the products. In addition, information is provided on the appearance potentials of the negative ions, the peak energies of the dissociative processes, and the energy integrated cross sections of the dissociative processes. (77 references). (auth)

27941 (ORNL-TM-1882) ELECTROCHEMICAL MEASUREMENTS ON IODIDE BAR TITANIUM AT ELEVATED TEMPERATURES. Gadiyar, H. S. (Oak Ridge National Lab., Tenn.). June 2, 1967. Contract W-7405-eng-26. 31p. Dep. CFSTI.

Electrochemical measurements on iodide bar titanium were made in oxygenated 0.05M K_2SO_4 and H_2SO_4 solutions at 240 and 257°C to obtain i-v characteristics, anodic film growth at constant potential, and in situ capacitance by pulse technique. Also included are ac impedance measurements made on these films at 25°C in different electrolytes. (auth)

27942 (TID-23837) STUDY OF THE REACTION BETWEEN DEUTERIUM ATOMS AND BROMINE MOLECULES USING CROSSED MOLECULAR BEAMS. Schmidt, Thomas William (Tennessee Univ., Knoxville). Mar. 1967. 79p. Dep. CFSTI.

Thesis.

The angular distribution of deuterium bromide product molecules form the reaction $D + Br_2 \rightarrow DBr + Br$. The possibility that the product was formed by wall reactions was considered. In the reaction at least 0.1% of the DBr produced is internally excited by an amount that equals 99% of the total available energy. Given the laws of classical mechanics and the angular distribution of the products and the reaction collision yield, estimation of the effects of impact

parameters on the distribution of internal energy in the products were made. (M.C.G.)

27943 (TRG-Report-1300) DEVELOPMENT OF IMPREGNATED CHARCOALS FOR TRAPPING METHYL IODIDE AT HIGH HUMIDITY. Collins, D. A.; Taylor, L. R.; Taylor, R. (United Kingdom Atomic Energy Authority, Sellafield (England)). Reactor Group). 1967. 44p. (CONF-660904-15). Dep. CFSTI. UK 5s. 6d.

From 9th Air Cleaning Conference, Boston.

Methyl iodide can be present in releases of iodine from irradiated fuel and at high humidity most activated charcoals will not provide efficient permanent retention of the methyl iodide. Impregnation of activated charcoal with certain amines or inorganic halides has been found to improve the retention of methyl iodide at high humidity. The best results are given by triethylenediamine or potassium iodide supported on 207B charcoal. The behavior of these two impregnated charcoals was examined in more detail. Design data are presented in the form of a linear relationship between log DF and stay-time in the charcoal bed, with a predicted allowance for ageing of charcoals exposed to a continuous flow of air. The performance during and after exposure to steam at high temperature was measured. The properties of the two recommended impregnants are to some extent complementary. Potassium iodide is not sensitive to carbon dioxide or high temperatures, but will not accept as high a loading of methyl iodide as triethylendiamine, and it lowers the ignition point of the charcoal. Its mode of action is not well understood and it may be less consistent in its performance and more readily poisoned. For application in reactor containment systems a mixture of the two types of impregnated charcoal is recommended. Tests of large-scale beds filled with the impregnated charcoal have given satisfactory results, but re-emphasise the importance of eliminating mechanical defects which can lead to by-passing of the charcoal. (auth)

27944 (UCLA-34P103-3) FAR INFRARED SPECTRUM OF SEVERAL SALTS OF QUADRIVALENT URANIUM. Technical Report No. 1. Stafsudd, Oscar M, Jr. (California Univ., Los Angeles. Dept. of Physics). Mar. 15, 1967. Contract AT(11-1)-34. 85p. Dep. CFSTI.

Thesis.

The frequencies of the fundamental infrared active lattice modes of several salts of quadravalent uranium were determined and compared with those determined by vibronic spectra of the same salts. The infrared frequencies range from 50 cm^{-1} to 250 cm^{-1}. A far infrared spectrometer was constructed in order to make these measurements. The spectrometer is useful over the range 25 cm^{-1} to 500 cm^{-1} and provides a resolution of at least 1 cm^{-1}. The salts investigated were Cs_2UBr_6, Cs_2UCl_6, and $[(CH_3)_4N]_2UCl_6$. Each of these salts has the uranium ion situated in the center of an octahedral complex of halogen ions. Two odd modes of this complex are infrared active and were observed both in vibronic and infrared spectra. These observations were generally in good agreement. Another odd mode of the complex in the vibronic spectra ($^3\Gamma_{2u}$) was absent in the far infrared spectra in accordance with the selection rules. The lowest frequency odd mode of the lattice can be described as the uranium halogen complex moving approximately as a ridged unit against its neighbors. This mode is also infrared active and was observed directly in the infrared and indirectly in vibronic spectra. These frequencies did not correspond closely as had the former frequencies. The interpretation given is that in the vibronic spectra, those portions of k-space with high density of states, other than k = 0, are important. (auth)

27945 (UCRL-50257) SOLUTION DENSITIES OF SODIUM BROMIDE AS A FUNCTION OF TEMPERATURE AND ANHYDROUS SALT CONTENT. Robison, William L.; Weston, Michael J. P. (California Univ., Livermore. Lawrence Radiation Lab.). May 4, 1967. Contract W-7405-eng-48. 158p. Dep. CFSTI.

The International Critical Tables give the solution densities of sodium bromide as a function of anhydrous salt content at intervals of 2% and as a function of anhydrous salt content at invervals of 10°C. A Lagrange polynomial generalized for two variables and requiring a double interpolation was used in conjunction with the data from these tables to generate tables with 0.1% intervals (from 1.00 to 28.00%) for anhydrous salt content and 0.1°C (from 0 to 36.3°C) for temperature. The density range is from ρ = 1.00118 to ρ = 1.27017. (auth)

27946 (NP-tr-1309) BULLETIN OF THE CHEMICAL SOCIETY, BELGRADE. Translation of Glas. Hem. Drus. Beograd, 28: No. 8-9, 411-522(1963). 97p. (TT-63-11452/8-9). CFSTI.

Research progress is summarized and a separate abstract was prepared for one paper. (M.C.G.)

For an abstract of the individual paper see: 27898.

27947 SYSTEMATICS OF ELECTRONIC STATES OF URANYL COMPOUNDS. Volod'ko, L. V.; Sevchenko, A. N.; Umreiko, D. S. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk SSSR, 172: 1303-4(1967). (In Russian).

On the basis of an analysis of numerous experimental investigations of the absorption and emission spectra of uranyl compounds in the frequency range 20000 to 30000 cm^{-1}, it is postulated that to explain the systematics of the electron spectra of these compounds it is necessary to consider transitions to four excited electronic states, and not to five states as claimed by McGlynn and Smith (J. Molec. Spectroscopy 6: 164, 1961). The discrepancy is attributed to the masking effects of electron transitions between the energy levels of the ligands. The level schemes of the uranyl nitrate complex, obtained on the basis of data by McGlynn and Smith and by the authors, are compared and it is asserted that in spite of some ambiguities in the latter case, the level scheme can serve as a starting point for interpretation of the electronic structure of uranyl compounds. (ATD)

27948 TWO-DIMENSIONAL ELECTROCHROMATOGRAPHY OF ^{106}Ru AND SOME OTHER RADIOMICROCONSTITUENTS IN SEA WATER. Marazovic, LJ.; Pucar, Z. (Inst. Ruder Boskovic, Zagreb). J. Chromatogr., 27: 450-9(Apr. 1967).

Two-dimensional electrochromatography, on filter paper sheets and filter paper sheets loaded with ion-exchange resins, of ^{106}Ru and some other microconstituents using sea water as a background electrolyte are described. The results are developed by radioautography on an x-ray film. Samples of ^{106}Ru from Amersham in chloride form (original in 8M HCl), and in nitrate form (original in 8M HNO_3), were used after a preliminary treatment. Experimental evidence shows that, in sea water, ^{106}Ru behaves very differently, depending on the form of the original sample (chloride or nitrate form). The two-dimensional electrochromatography of ^{106}Ru in sea water showed a relatively large number of well-defined species which could be readily classified into anionic, cationic, electroneutral, particulate, non-adsorbable, and more or less adsorbable species on filter paper. Although anionic fractions, as expected, were strongly adsorbed on anion ion-exchange paper (Dowex 2-X8), cationic fractions of ruthenium in chloride form were not adsorbed on cation ion-exchange filter paper (Dowex 50). The same experiments were also performed starting from RuO_4, which was obtained by a distillation method. The fate of RuO_4 and soluble species resulting from decomposition of the tetroxide in HCl and HNO_3 solutions and in sea water, was studied. (auth)

27949 ISOTOPIC EXCHANGE REACTION BETWEEN BIS(α-BENZILDIOXIMATO)NICKEL(II) AND NICKEL IONS IN PYRIDINE AND PYRIDINE-WATER SOLUTIONS. Hirota, Reiko; Saito, Nobufusa (St. Paul's Univ., Tokyo). Bull. Chem. Soc. Jap., 40: 1159-62(May 1967).

The rate of isotopic exchange between bis(α-benzildioximato)-nickel(II) and nickel ions in pyridine greatly increased in the presence of water. When the water content in pyridine was lower than 3 M, the reaction took place according to the rate equation: Rate = k_1(complex) + k_2(complex)(Ni^{2+})(H_2O). For the catalyzed step, a mechanism is proposed. (auth)

27950 REACTIVITY OF ELECTRON DONOR-ACCEPTOR COMPLEXES. VII. HYDROGEN EXCHANGE REACTION OVER ELECTRON DONOR-ACCEPTOR COMPLEXES OF AROMATIC COMPOUNDS. Ichikawa, Masaru; Soma, Mitsuyuki; Onishi, Takaharu; Tamaru, Kenzi (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 1294(May 1967).

The catalytic activity for the H-D exchange reaction via the chemisorption mechanism was examined over the electron donor-acceptor (EDA) complexes of various aromatic compounds. The effective surface for hydrogen chemisorption was estimated from the exchange equilibrium between D_2 and the complex to form HD at comparatively low temperatures. The experimental conditions were controlled so that the amount of exchangeable hydrogen was of the same order of magnitude for various complexes. The actual amount of exchangeable hydrogen was used to normalize the H-D exchange rates. The relative first-order rate constants and the activation energies for the H-D exchange reaction via chemisorption at 80°C were plotted against the electron affinity of acceptor molecules in the EDA complexes. The activity of the EDA complexes was strongly dependent on the electron affinity of acceptor molecules. The activity had a maximum in the range of 0 to 0.6 eV electron affinity of the acceptor molecule. The catalytic activity was strongly dependent on the number of substituents of a given kind. (D.H.M.)

27951 PREPARATION OF HIGH-PURITY BERYLLIUM COMPOUNDS BY SOLVENT EXTRACTION. Grinstead, Robert R.; Surls, Joseph P. Jr. (Dow Chemical Co., Walnut Creek, Calif.). Nucl. Sci. Eng., 28: 346-52(June 1967).

A solvent extraction process is described for the preparation of

very high-purity beryllium compounds. The process involves extraction of beryllium from an aqueous solution containing sufficient ethylenediaminetetraacetic acid (EDTA) to complex all extractable impurities. The extractant used is a kerosene solution of 2-ethylhexoic acid. Further purification is accomplished by scrubbing the organic phase with 4M sulfuric acid. The purified beryllium can be removed either with strong aqueous HCl or HF. Fifteen pounds of beryllium sulfate tetrahydrate, to which various impurities were added, were treated by this process in three batches, and converted to ammonium beryllium fluoride of high purity. Analyses of these products are given. (auth)

27952 THE ELECTRICAL CONDUCTIVITY OF POTASSIUM CHLORIDE IN HEAVY WATER IN THE -2 TO 12° RANGE. Horne, R. A.; Johnson, D. S. (Arthur D. Little, Inc., Cambridge, Mass.). J. Phys. Chem., 71: 1936-7(May 1967).

In order to determine whether the greater structure of D_2O (compared to H_2O) is reflected in the energetics of transport processes, the temperature dependence of the electric conductivity of solutions of KCl in D_2O in the −2 to 12°C range were measured. Results of the measurements of equivalent conductances of 0.10M KCl in H_2O and in D_2O and 1.0M KCl in D_2O are given. The maximum in the activation energy for 0.10M KCl in D_2O was higher (4.5 kcal/mole compared to 4.2 kcal/mole) than in H_2O and was displaced to a somewhat higher temperature (5°C compared to 2.5°C) as might be expected from the greater structure in D_2O. For 1.0M KCl in D_2O a maximum of 4.2 kcal/mole appeared at 3°C. (D.H.M.)

27953 ^{31}P CHEMICAL SHIFTS OF PHOSPHONATE ANIONS. Riess, Jean G.; Van Wazer, John R.; Letcher, John H. (Monsanto Co., St. Louis). J. Phys. Chem., 71: 1925-7(May 1967).

The ^{31}P chemical shifts of a number of phosphonates under carefully controlled conditions and recently published chemical shifts of quaternary triphenylphosphonium salts were compared in light of the general theory and the problem of measuring electron-donating ability. The ^{31}P chemical-shift measurements of the phosphonates were carried out on aqueous solutions in the range of 0.1 to 0.5M in phosphorus. In order to avoid complications due to hydrogen association and hydrogen bonding and to make the data comparable, solutions of the phosphonic acids were brought to pH 14 by addition of tetramethylammonium hydroxide. If the P−O π bonding and the OPO bond angles in the phosphonates were not affected by the change of the R substituent, a plot of the ^{31}P chemical shifts of variously substituted phosphonate anions vs. the chemical shifts of quaternary triphenylphosphonium compounds having the same substituents would be a straight line, however the plot was not a straight line indicating that varying the R organic substituent affected the P−O bond order to a small extent. Therefore the great sensitivity of the ^{31}P chemical shift to the occupation of the phosphorus d_π orbitals renders the phosphonates a poor tool for estimating the electron-donating ability of organic groups. Both bond-distance data and the observed ^{31}P chemical shifts of triphenylphosphine and the tetraphenylphosphonium ion indicated that there was little or no π character in the P−C bond between a phenyl group and a phosphorus atom. Therefore it seems reasonable to ascribe essentially all of the π effects to the P−O bonds of the phosphonate anions. (D.H.M.)

27954 KINETICS OF DEUTERIUM EXCHANGE OF TRIMETHYLAMMONIUM ION IN D_2SO_4. Fraenkel, Gideon; Asahi, Yutaka (Ohio State Univ., Columbus). J. Phys. Chem., 71: 1706-9(May 1967).

The kinetics of exchange protolysis of trimethylammonium nitrate in D_2SO_4 were examined over the temperature range from 41 to 103°C employing NMR integration to determine the rate constants. The exchange reaction was first order in the protonated base and the rate constants correlated well with Arnett's acidity function H'''. The mechanism proposed to account for these results involves the rate-determining dissociation $BH^+ + D_2O \xrightarrow{k_{1S}} B + HD_3O^+$. The rate constants are given by $\log (k_{1S}/T) = -(3313/T) + 8.08 \log T - 12.18$. At 50°C $\Delta H^\ddagger$ was 22 kcal. (auth)

27955 RATE CONSTANTS FOR DEUTERIUM EXCHANGE OF TRIMETHYLAMMONIUM ION IN HEAVY WATER. Day, Robert J.; Reilley, Charles N. (Univ. of North Carolina, Chapel Hill). J. Phys. Chem., 71: 1588-95(May 1967).

Rate constants for deuterium transfer in D_2O solutions of trimethylammonium ion at 33°C were measured by proton magnetic resonance from the collapse of proton−deuterium coupling. The mechanisms advanced earlier to describe the corresponding proton−transfer rates are also adequate for deuterium exchange. The rate of the direct reaction with solvent, $BD^+ + D_2O \xrightarrow{k_4} B + D_3O^+$, extrapolated to infinite dilution is $k_4 = 1.08\ sec^{-1}$ while, for the symmetric reaction $BD^+ + OD_2 + B \xrightarrow{k_7} B + DOD + DB^+$, $k_7 = 1.12 \times 10^8\ M^{-1}\ sec^{-1}$. The decrease of k_4 at high D^+ concentrations interpreted by the mechanism $B\ldots(DOD)_m \xrightarrow{k_{DB}} B + mDOD$ gives $k_{DB} = 8.5 \times 10^9\ sec^{-1}$. The direction and magnitudes of the isotope effects on the rate parameters are consistent with the postulated mechanisms. (auth)

27956 HYDROLYSIS OF URANIUM MONONITRIDE. Dell, R. M.; Wheeler, V. J.; Bridger, N. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 63: 1286-94(May 1967). (AERE-R-4984).

An experimental study was made of the hydrolysis of UN in water vapour + argon mixtures of controlled composition. The reaction kinetics were followed gravimetrically and by estimation of the ammonia liberated. For powdered UN the reaction proceeds rapidly above ~340°C. Some specimens hydrolyze completely to UO_2, ammonia, and hydrogen ($UN + 2H_2O \rightarrow UO_2 + NH_3 + \frac{1}{2}H_2$), whereas others yield a solid product containing significant amounts of αU_2N_{3+x} and dissolved nitrogen. The difference is ascribed to particle texture. When the release of ammonia is inhibited it reacts further with UN to form αU_2N_3. The overall activation energy of hydrolysis is 21 kcal/mole. Experiments with single crystals of UN, hydrolyzed at higher temperatures, showed that an epitaxially oriented sandwich structure of αU_2N_3 and UO_2 is formed on the surface of the crystal, exactly as during oxidation. This surface film protects UN from hydrolysis at low temperatures. Some experiments on the hydrolysis of UC single crystals are also described. (auth)

27957 CATALYSIS OF HYDROGEN EXCHANGE IN m-DINITROBENZENE. Buncel, E.; Zabel, A. W. (Queen's Univ., Kingston, Ont.). J. Amer. Chem. Soc., 89: 3082-4(June 7, 1967).

The nuclear hydrogen abstraction process in the interaction of aromatic nitro compounds with bases was investigated by deuterium exchange. The effects of a number of Brønsted bases and also of reaction medium on the exchange of the 2-hydrogen in 1,3-dinitrobenzene was studied. The media examined were dimethylformamide (DMF), dimethyl sulfoxide (DMSO), and dimethyoxyethane (DME), containing deuterium oxide. The extent of exchange under standard conditions was taken to be a measure of the relative abstracting abilities of the bases in the particular media. The results indicated a dependence of reactivity on medium and base. The DMF and DMSO media were about equally facile in base catalysis and were much more effective than DME. Among the anionic bases the reactivity order for DMF media was $DO^- > PhO^- > S_2O_3^{3-} \approx AcO^- > N_3^-$. The data for the amines did not fall in definite order, consistent with the known medium dependence of relative base strengths of primary, secondary, and tertiary amines. The common mechanism for the exchange processes was taken to be rate-determining abstraction of hydrogen by the Brønsted base, followed by fast protonation by solvent of the resulting carbanion. (D.H.M.)

27958 MECHANISM OF ISOTOPIC EXCHANGE BETWEEN ARYLMERCURIC COMPOUNDS AND ELEMENTAL MERCURY. Kreevoy, Maurice M.; Walters, Edward A. (Univ. of Minnesota, Minneapolis). J. Amer. Chem. Soc., 89: 2986-92(June 7, 1967).

The mechanism of the facile isotope exchange between arylmercuric compounds in solution and metallic mercury was examined. All reasonable mechanisms except a true isotopic exchange at the surface of the liquid were eliminated. The reaction rate was not significantly limited by mass transport in either phase. The reaction showed real but small solvent dependence which was not correlated with the solubility of the substrate or any common solvent parameter. This and the value of $\Delta S^\ddagger$ favor a rate-determining chemisorption step. The efficiency of substrate collisions with the metal was much higher than that of collisions with the Hg^0 atoms in solution for bringing about exchange, suggesting a rate-determining electron transfer. Reactivity seems to be in the order RHgI > RHgBr > RHgCl > RHgOAc >> RHgR. An over-all mechanism is proposed. (auth)

27959 PROTON EXCHANGE OF TRIETHYLAMMONIUM ION IN AQUEOUS SOLUTION. Ralph III, E. K.; Grunwald, Ernest (Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc., 89: 2963-7(June 7, 1967).

Rates of exchange of NH protons of triethylammonium ion (BH^+) with H_2O and D_2O were measured by NMR techniques in acid solutions over a range of pH. The following reactions and rate constants (corrected to infinite dilution) were found: $BH^+ + OH^-$, $k_{-b} = (1.7 \pm 0.5) \times 10^{10}\ sec^{-1}\ M^{-1}$ at 30°C; $BH^+ + OH_2 + B$ (symmetrical exchange, $k_2 = (1.82 \pm 0.08) \times 10^8\ sec^{-1}\ M^{-1}$ at 30°C; $B + H_3O^+$, $k_{-a} = 2 \times 10^{10}\ sec^{-1}\ M^{-1}$ at 25°C; $B \cdot HOD + D_2O \rightarrow B \cdot DOD + HOD$, $k_H^* = (3.1 \pm 0.5) \times 10^9\ sec^{-1}$. Of these rate constants, only k_2 was considerably smaller than expected from data for methylamines, probably due to steric hindrance. Acid dissociation constants are reported for BH^+ as a function of BHCl concentration; $pK_A^\circ = 10.81$ at 25°C. H_2O-D_2O solvent isotope effects on K_A are discussed. (auth)

27960 SECONDARY DEUTERIUM KINETIC ISOTOPE EFFECTS IN RADICAL-FORMING REACTIONS. II. THE DECOMPOSITION OF t-BUTYL PERPIVALATE. Koenig, T.; Wolf, R.

(Univ. of Oregon, Eugene). J. Amer. Chem. Soc., 89: 2948-52 (June 7, 1967).

Measurement of the rates of decomposition of t-butyl perpivalate and its deuterated analog showed the secondary deuterium kinetic isotope effect on the formation of t-butyl radical was 1.02 per deuterium. The theories proposed to explain these isotope effects are compared using the present data and that for the formation of t-butyl cation. (auth)

27961 SECONDARY DEUTERIUM ISOTOPE EFFECTS ON A CYCLIC ALLYLIC REARRANGEMENT. McMichael, Kirk D. (Washington State Univ., Pullman). J. Amer. Chem. Soc., 89: 2943-7(June 7, 1967).

Secondary α- and γ-deuterium isotope effects on the cyclic intramolecular rearrangement of allyl thionbenzoate to allyl thiolbenzoate were measured. The α effect (1.06) was significantly smaller than that observed for (1.10 to 1.12) carbonium ion, carbanion, or radical pathways. With the γ effect (0.97), this result indicates that these effects are useful mechanistic criteria for allylic rearrangements. These results also indicate that the transition state structurally resembles reactant more than product, suggesting that this type of study will be useful in characterizing the position of a transition state along a reactant–product coordinate in such reactions. (auth)

27962 MIXED LIGAND CHELATES OF URANIUM(IV). Carey, G. H.; Martell, A. E. (Illinois Inst. of Tech., Chicago). Contract AT(11-1)-1020. J. Amer. Chem. Soc., 89: 2859-65 (June 7, 1967). (COO-1020-17).

Potentiometric studies are described for mixed ligand U(IV) chelate formation with ethylenediaminetetraacetic acid (EDTA) and nitrilotriacetic acid (NTA) as primary ligands. Secondary ligands studied are salicylic acid (SA), 5-sulfosalicylic acid (SSA), disodium 1,2-dihydroxybenzene-3,5-disulfonate (Tiron), pyrocatechol (PY), 5-sulfo-8-hydroxyquinoline (HQS), disodium 1,8-dihydroxynaphthalene-3,6-disulfonate (CS), o-phthalate (Ph), and iminodiacetic acid (IMDA). For the mixed ligand chelate systems containing EDTA, combination with the primary ligand was complete before combination with the secondary ligand took place. For the less stable NTA systems, overlapping of reactions of the primary and secondary ligands was much more extensive. The relative magnitudes of the equilibrium constants for combination of secondary ligands with the U(IV)–EDTA chelate are CS > Tiron > PY > SSA > HQS > IMDA >> Ph. The mixed ligand chelates of U(IV) are more stable than those of Th(IV) by 1 to 3 log K units. (auth)

27963 APPLICATION OF ELECTRON SPIN RESONANCE IN THE STUDY OF TRIPLET STATES. I. COMPARISON OF THE GROWTH OF TRIPLETS IN PHENANTHRENE AND PHENANTHRENE-d_{10}. Brinen, J. S.; Hodgson, W. G.; Orloff, M. K. (American Cyanamid Co., Stamford, Conn.). J. Mol. Spectros., 23: 112-15(May 1967).

ESR results are reported of relative triplet-state-concentration measurements on phenanthrene and phenanthrene-d_{10}. Both light and heavy molecules of the uv-irradiated samples were measured and then converted to steady-state concentrations. The ratio (T_D/T_H) for phenanthrene was 1.6. Deuteration effects are discussed and comparisons are made with previous studies on naphthalene. Optical density measurements verified the ESR determination for the phenanthrene ratio of triplet state; however, conclusions drawn from the measurements suggest that further study of this system is necessary. (P.C.S.)

27964 VIBRATION ROTATION BANDS OF C_2T_2. PART I. ν_3. Jones, Llewellyn H. (Los Alamos Scientific Lab., N. Mex.); Goldblatt, Maxwell; McDowell, Robin S.; Armstrong, Dale E.; Scott, James F.; Williamson, James G.; Rao, K. Narahari. J. Mol. Spectros., 23: 9-14(May 1967). (COO-882-10).

C_2T_2 was prepared, and its infrared absorption spectrum examined under high resolution. Rotational analysis of the ν_3 fundamental was made, and a value $B_0 = 0.6621_5 \pm 0.00020$ cm^{-1} obtained. Other bands observed include ν_3, $\nu_4 + \nu_5$ and possibly $\nu_2 + \nu_5$, $\nu_3 + \nu_4$, $-\nu_4$ and $\nu_2 - \nu_5$. (auth)

27965 RARE GAS MOBILITY IN PURE AND DOPED POTASSIUM BROMIDE. Matzke, Hj. (Technische Hochschule, Brunswick). Z. Naturforsch., 22a: 507-18(Apr. 1967).

The mobility of the inert gases argon and xenon in pure and doped single crystals of KBr was studied. The gases were introduced by ion bombardment. The recently established system of stages was used to interpret the results. Normal volume diffusion was found for xenon at low gas concentration, the activation enthalpy being 1.4 ± 0.2 eV. This release was independent of doping, thus favoring a transport process for xenon independent of single vacancies. As much probable alternative, a mobility via small vacancy clusters, e.g., vacancy pairs was suggested. Trapping of xenon was found at higher xenon concentrations. This retarded release was shown to depend on doping and was more pronounced in crystals with an excess of cation vacancies. The diffusion of argon occurred with a similar activation enthalpy, but was most probably due to an interstitial motion. (auth)

27966 PARAMAGNETIC ELECTRON RESONANCE OF ^{99}Tc(IV) IN HEXAHALOGENO COMPLEXES. Roemelt, Gerhard (Technische Hochschule, Clausthal, Ger.); Schwochau, Klaus. Z. Naturforsch., 22a: 519-22(Apr. 1967). (In German).

The hyperfine structure of ^{99}Tc(IV) in mixed crystals of $K_2[TeCl_6]-K_2[PtCl_6]$ and $K_2[TcF_6]-K_2[PtF_6]$ was measured at 3 cm wavelength and at 1.7 and 77°K, respectively. The parameters of the chloro-complex are $g_{max} = 1.9896$, $g_{min} = 1.9876$, $A_{max} = 1.361 \times 10^{-2}$ cm^{-1}, $A_{min} = 1.337 \times 10^{-2}$ cm^{-1}; in addition to the $\Delta m = 0$ transitions, the forbidden $\Delta m = \pm 1$ transitions were observed. The parameters of the polycrystalline fluoro-complex were determined to $g = 3.884$, $A = 3.34 \times 10^{-2}$ cm^{-1}, $B = 1.76 \times 10^{-2}$ cm^{-1}. (auth)

27967 INFLUENCE OF THE ELECTRON-DONOR PROPERTY OF LIGANDS ON THE COMPOSITION OF COORDINATION SPHERES IN URANYL PERCHLORATE COMPOUNDS. Vdovenko, V. M.; Mashirov, L. G.; Suglobov, D. N. Radiokhimiya, 9: 37-45(1967). (In Russian).

In the frequency interval of valency oscillations of ClO_4^- the oscillation spectra of solutions of uranyl perchlorate were measured in different organic solvents. The degree of substitution of ClO_4^- by the solvent in the coordination sphere of UO_2^{2+} was determined by the basicity of the solvent molecule and its dielectric permeability. The effect of dielectric permeability was considered from the viewpoint of the correlation between dielectric constant and the energy of the solvated anion. On the basis of spectroscopic data the character of the coordination of the anions and the coordination number of UO_2^{2+} in uranyl perchlorate complexes with pyridine, antipyrine, TBP, dibutyl ether, camphor, acetonitrile, and nitromethane, and in antipyrine complexes of uranyl sulfates and oxalates were determined. The displacement of the frequencies of the antisymmetric valency oscillations of uranyl $\Delta\tilde{\nu}_3$, attached to one ligand, were calculated. The sequence of the changes of $\Delta\tilde{\nu}_3$ corresponds with the capacity of the ligands to displace others in the coordination sphere. (tr-auth)

27968 SOLUBILITY OF COMPLEX SALTS OF QUATERNARY AMMONIUM THORIUM HEXANITRATES IN NITRIC ACID SOLUTIONS. Nikol'skii, B. P.; Posvol'skii, M. V.; Mark, G. S. Radiokhimiya, 9: 46-52(1967). (In Russian).

The solubility of salts containing thorium hexanitrate anions and organic cations of the alkyldimethylbenzylammonium series $X\text{-}N^+(CH_3)_2CH_2C_6H_5$ (X = H, CH_3, C_2H_5, C_3H_7, and C_4H_9) in 6 to 9 N nitric acid was investigated at different temperatures. The solubility decreased regularly with increasing length of the alkyl radical on the quaternary nitrogen. The change of the free energy, enthalpy, and entropy of the dissolution of the salt with increasing length of the alkyl radical on the C_2H_4 group was calculated. It was shown that because of the monotype structure and the proximity of the fusion temperature of the salt the change of solubility of the salt can be explained by the change of the heat of hydration of the cation of the quaternary base. For the first members of the homologic series the change of the solubility is always connected with a change in the entropy. The heat of hydration, characteristic of the CH_2 group on its introduction into the hydrocarbon chain, and the change of the energy of the crystalline lattice of the salt during change of the even numbers of the C atoms in the radical of the displaced ammonia were calculated. (tr-auth)

27969 PROBLEMS OF METAL HYDROXIDE SOLUBILITY PRODUCTS. Davydov, Yu. P. Radiokhimiya, 9: 52-7(1967). (In Russian).

It is shown that the size of the solubility products of metal hydroxides is not a constant characteristic of all ranges of the possible formation of hydroxide precipitates. Data are presented for plutonium hydroxides. (tr-auth)

27970 STUDIES OF TERNARY SOLUTIONS BY ISOPIESTIC METHOD. IX. SOLUTIONS WITH STRONG CHEMICAL INTERACTION. Kirgintsev, A. N.; Luk'yanov, A. V. Radiokhimiya, 9: 62-7(1967). (In Russian).

Ternary solutions of $UO_2SO_4-Me_2SO_4-H_2O$ where Me = H, Li, Na, and NH_4 were studied at 25°C by the isopiestic method. It was shown that all ternary solutions have a negative deviation from the ideal. The degree of this deviation increased with increases in the radius of Me. (tr-auth)

27971 NEW QUADRUPOLE AND FORBIDDEN LINES IN THE L-EMISSION SPECTRA OF YTTERBIUM AND LUTETIUM. Nigam, A. N.; Kapoor, Q. S.; Garg, K. B. (Univ. of Rajasthan, Jaipur, India). Z. Naturforsch., 22a: 572(Apr. 1967).

The presence of four new diagram lines at 1202.5, 1439.3, 1769.8, and 1237.4 X.U. in the L-spectrum of ytterbium is reported. The first three lines correspond to the quadrupole transi-

tions $L_IN_{IV,V}(\gamma_{II})$, $L_{III}N_{III}$, and $L_{III}M_{III}$, respectively. The fourth line was assigned to the forbidden transition L_IN_I. Five new diagram lines at 1715.3, 1237.9, 1247.2, 1193.2, and 1144.8 X.U. in the L-spectrum of lutetium were found. The first two lines correspond to the quadrupole transitions $L_{III}M_{III}(S)$ and $L_{II}N_{III}$, respectively. The last three lines were assigned to the forbidden transitions $L_{III}N_{II}$, L_IN_I, and L_IO_I, respectively. (D.H.M.)

27972 RADIATION-INDUCED REACTIONS WITH CELLULOSE. II. THE TROMMSDORFF EFFECT: DOSE AND DOSE RATE STUDIES INVOLVING COPOLYMERIZATION WITH MONOMERS IN METHANOL. Dilli, S.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). J. Appl. Polymer Sci., 11: 839-58(June 1967).

The radioinduced grafting to cellulose of styrene, methyl methacrylate, vinyl acetate, 2-vinylpyridine, and 4-vinylpyridine in methanol was studied. All monomers exhibit appreciable grafting at room temperature in either vacuum or air for total doses up to 10 MRAD and at dose rates as high as 1.4 MRAD/hr in a spent fuel or ^{60}Co facility. The magnitude of the grafting depends on both the total dose and dose rate. Under certain experimental conditions, the grafting experiences a maximum that is attributed to the Trommsdorff effect. A novel mechanism involving charge-transfer bond formation is proposed for the grafting reactions. (auth)

27973 INVESTIGATION OF THE FORMATION, THERMAL DECOMPOSITION, AND STRUCTURE OF THE UO_3-H_2O SYSTEM. II. SPECTROSCOPIC INVESTIGATION OF THE FORMATION, THERMAL DECOMPOSITION AND STRUCTURE OF α-UO_3-2H_2O. Fodor, Miklos; Mink, Janos; Poko, Zoltan. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 133-64(1967). (In Hungarian).

It was established from data obtained by derivatography and infrared spectroscopy that the hydrolysis of β- and amorphous UO_3 at room temperature, leads to products of α-$UO_3 \cdot 2H_2O$ composition and modification with identical properties. This type of compound is of complex structure containing, in addition to water molecules in two kinds of bonds, hydroxyl groups as well. Because of the relative quantities of the components with different bond strengths, the molecular structure can be described only by a trimeric formula, or by a formula corresponding to an integral multiple of a trimeric form. One kind of water has diffuse bond strength and is probably water between individual layers, while the other is a structural water of definite bond strength which may form various hydrogen bridge bonds. (auth)

27974 PROPERTIES OF RADIOACTIVE ELEMENT COLLOIDS. Davydov, Yu. P. Radiokhimiya, 9: 94-105(1967). (In Russian).

An analysis of literature data on the colloidal properties of microquantities of radioactive elements is presented. It is shown that the presence of the maxima of K_{ads} as a function of pH of the solution can be caused by irreversible adsorption of the radioelement on colloidal impurities, that is by the formation of pseudocolloids. Data showed that attainment of the numerical value of the solubility products of radioelement hydroxides in microconcentrations in solutions is a necessary but inadequate condition for the formation of actual colloids of radioactive elements. (tr-auth)

27975 STRUCTURE OF URANYL NITRATE HEXAHYDRATE. Vdovenko, V. M.; Stroganov, E. V.; Sokolov, A. P. Radiokhimiya, 9: 127-30(1967). (In Russian).

An examination of studies on the structure of $UO_2(NO_3)_2 \cdot 6H_2O$ indicated that the most probable structure of this complex compound is the following: linear uranyl ions in the equatorial plane are surrounded by two bidentate additive nitrate groups and two molecules of water and the remaining four H_2O molecules are found outside the coordination sphere of the uranyl ion. (tr-auth)

27976 URANIUM DIOXIDE REACTIONS WITH RARE EARTH (La, Sm, Dy, AND Yb) OXIDES IN A VACUUM AT HIGH TEMPERATURES. Koshcheev, G. G.; Kovba, L. M. Radiokhimiya, 9: 130-2(1967). (In Russian).

Powdered mixtures of rare earth (La, Sm, Dy, and Yb) oxides and uranium dioxide were pressed into pellets at a pressure of 3 t/cm^2 and heat-treated at 1600 to 1800°C at a pressure of 10^{-4} mm, then the pressing and heat-treatment operations were repeated to achieve greater homogeneity and a more extensive reaction. The U(VI) content and total uranium were determined by coulometric analysis at a controlled potential, and x-ray phase analysis was also carried out. The results showed the existence of three phases in $R_2O_3-UO_{2+x}$ systems (R being La, Sm, Dy, or Yb): a cubic solid solution with a fluorite structure, a body centered cubic solid solution different from C type, and rare earth oxide phases. The degree of oxidation of uranium was found to depend on the rare earth oxide content. As the R_2O_3 content rises to 40.0 mole %, the degree of oxidation of uranium increases. All the samples were pyrophoric, particularly those containing 40.0–50.0 mole % R_2O_3. Thus, the sample with 50.0 mole % Sm_2O_3 oxidized in air to a ratio O : U = 2.88. (CFSTI)

27977 THERMAL STUDIES OF UO_2–MoO_3 SYSTEM. Efremova, O. A.; Trunov, V. K.; Kovba, L. M. Radiokhimiya, 9: 132-4(1967). (In Russian).

The existence of the individual compounds $UMoO_5$, UMo_2O_8, and $UMo_{11}O_{35}$ in the system UO_2-MoO_3 was confirmed thermographically. The polymorphic conversion of α-UMo_2O_8 at 1000°C was detected in the high-temperature modification of β-UMo_2O_8. It was shown that all three compounds are decomposed by peritectic reactions. The condensed constitution diagram of the binary system UO_2-MoO_3 in the coordinates of composition and temperature (P constant) was constructed for the composition range of 50 to 100 mol% MoO_3. At temperatures from 1040 to 1100°C oxidation-reduction processes between U(IV) and Mo(VI) and U(V) and Mo(V), respectively, easily occur. (tr-auth)

27978 VIBRATIONAL SPECTRUM OF CRYSTALLINE HF AND DF. Kittelberger, J. S.; Hornig, D. F. (Princeton Univ., N. J.). J. Chem. Phys., 46: 3099-3108(Apr. 15, 1967).

Infrared spectra of pure crystalline HF and DF were obtained over the region from 30 to 4000 cm^{-1} and the spectra of dilute isotopic mixed crystals were studied in the intramolecular region 2000 to 4000 cm^{-1}. Four bands were found in the stretching region of pure DF crystals, as well as the previously-reported four in the corresponding region of the HF spectrum. Direct observation of a lattice band near 200 cm^{-1} in both HF and DF, together with the line spacing in the stretching region, permits an unambiguous assignment of the extra pair of lines in the intramolecular region as combination bands. The Raman spectra of crystalline HF and DF reveal four lines in the stretching region and one lattice transition. With the aid of simple intensity rules and correlations with the other hydrogen halides, a complete assignment of the vibrational bands was made except for the librational region, where the multiplicity of lines and the peculiar behavior of one of them under different deposition conditions make a firm interpretation impossible. The assignment is discussed with reference to results obtained by inelastic neutron scattering. Within experimental error each Raman line is coincident with an infrared line, and the structural implications of this fact are discussed. (auth)

27979 ENERGY DISTRIBUTION OF HOT ATOMS IN A REACTIVE SYSTEM. Felder, R. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Phys., 46: 3185-92 (Apr. 15, 1967).

A binary system of hot and thermal atoms is considered in which interactions are governed by an inverse-power potential, and reactions between interacting atoms occur with a probability equal to a constant between two energies and zero elsewhere. Solutions of the time- and space-independent Boltzmann equation were obtained, and used to develop criteria for the validity of the expression for the hot-atom collision density assumed by Wolfgang and Estrup in their kinetic theory of hot-atom reactions. It was found that this expression has its greatest validity for relatively isotropic scattering, a low reactivity, and a large difference between the masses of the interacting species. Errors in the probability that a hot atom reacts before becoming thermalized which result from the assumed form of the collision density are generally of the order of 1 to 10%, but for an interaction potential as soft as the inverse sixth power and equal masses the error may be as high as 25%. (auth)

27980 ON THE INFRARED SPECTRA OF HNCS AND DNCS. Durig, J. R.; Wertz, D. W. (Univ. of South Carolina, Columbia). J. Chem. Phys., 46: 3069-77(Apr. 15, 1967).

The infrared spectra of gaseous and solid HNCS and DNCS are reported. The infrared spectra of both molecules isolated in an argon matrix are also reported. The shift in frequency of the N–H and N–D stretching vibrations on solidification is 440 and 293 cm^{-1}, respectively, which suggests a very short and strong hydrogen bond. Two of the low-frequency bending modes are identified for the HNCS molecule and reassignments are given. Assignment of the six fundamental vibrations for the DNCS molecule are proposed and discussed. Gas-phase analysis of the N–H stretching vibration centered at 3537.9 cm^{-1} gives the A rotational constant of 43.35 ± 0.5 cm^{-1} for the ground state and 36.67 ± 0.5 cm^{-1} in the excited state. The mass defect is calculated to have a value at 0.184 amu · Å^2. (auth)

27981 CONTRIBUTION TO THE KNOWLEDGE OF THE ELECTROCHEMISTRY OF URANIUM IN MOLTEN LiCl–KCl EUTECTIC. IV. THE POTENTIAL OF THE COUPLE U(III)/U(0). Caligara, F.; Martinot, L.; Duyckaerts, G. (Univ., Liege). Bull. Soc. Chim. Belges, 76: 211-20(Mar.-Apr. 1967).

The standard potentials of the system U(III)/U(0) were mea-

sured in the molten LiCl-KCl eutectic at 400 to 550°C. The work has been carried out in glove-boxes, under inert atmosphere, and special care was taken in preventing even the slightest oxidation of U(III). A comparison was made with previous results, obtained by different authors. The cell used was U|LiCl, KCl, U^{3+}||LiCl, KCl, AgCl|Ag. (auth)

27982 CALCULATION OF THE DISSOCIATION ENERGY OF CALCIUM AND URANIUM MONOFLUORIDE. Kudrin, L. P.; Mazeev, M. Ya. At. Energ. (USSR), 22: 85-9(Feb. 1967). (In Russian).

The dissociation energies of CaF and UF molecules were calculated by the variation method. During this decomposition the electron density of Ca^+ was calculated by the statistical atomic model and in the Hartree-Fock approximation, and for U^+ the electron density was calculated by the statistical model on the basis of the ion potential. The electron density of F^- was calculated by the Hartree-Fock approximation. For CaF in both cases, values were obtained for the dissociation energy that agreed well with the experimental results. For UF the experimental data did not agree. (tr-auth)

27983 EQUILIBRIUM ISOTOPE EFFECTS WITH VARIOUS IODINE ISOTOPES. Elias, H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 213-14(Dec. 1966). (In German).

The results of a study are reported in which the distribution of ^{125}I and ^{131}I between methylene iodide and iodide ions in dimethylformamide was measured in exchange equilibrium. The results showed that the $^{125}I/^{131}I$ ratio in iodide ions after isotope exchange is smaller than before exchange; in exchange equilibrium ^{131}I in iodide ions is somewhat enriched in comparison to ^{125}I. (J.S.R.)

27984 A STUDY OF THE MODERATELY RAPID ISOTOPIC EXCHANGE BETWEEN IODOACETIC ACID AND IODIDE IONS IN ACETONE. Beronius, Per (Univ. of Umea, Sweden). Z. Phys. Chem., (Frankfurt), 54: 266-72(May 1967).

The exchange of iodine between iodoacetic acid and sodium iodide in acetone was investigated over a temperature range from 15.0 to 48.5°C at total reactant concentrations below 0.009M. The half-times of exchange were of the order of seconds and it was necessary to apply the integral method to obtain rate data. The exchange is of the S_N2-type with an activation energy of 15,500 cal/mole. The pre-exponential factor is 6.80×10^{13} l/mole/sec and the activation entropy is zero within the limits of experimental errors. (auth)

27985 IMINE-ENAMINE TAUTOMERISM. PART IX. MECHANISMS OF THE cis-trans ISOMERIZATION OF ENAMINO KETONES. Dabrowski, Janusz; Terpinski, Jacek (Inst. of Organic Chemistry, Warsaw. Inst. of Tech., Warsaw). Rocz. Chem., 41: 697-706(1967).

The NMR spectra of enamino ketones treated with D_2O and ND_3 showed the exchange of the a-vinyl hydrogen for deuterium. On this basis a mechanism of cis-trans isomerization of enamino ketones proceeding via ketimine was proposed. The ratio of the rate of isomerization and of that of isotopic exchange suggests other mechanisms occurring concurrently. (auth)

27986 TELLUR I TELLURIDY. (Tellurium and Tellurides). Chizhikov, D. M.; Schastlivyi, V. P. Moscow, Izdatel'stvo Nauka, 1966. 279p.

Extensive data are given on the properties, application, production, and industrial uses of tellurium. The natural resources, geochemistry, and mineralogy of tellurium and ore-bearing tellurium deposits are reviewed as well as the technological schemes for tellurium production, separation, and purification. Physicochemical properties of tellurides, synthesis, preparation, and refining of tellurides, and preparation of telluride and tellurium films are discussed. Detailed information is given on the electrophysics electro-optical properties of tellurides. Toxicity of tellurides and tellurium is also considered. Comprehensive bibliographies for each chapter are included. (R.V.J.)

27987 YADERNYI MAGNITNYI REZONANS V POLIMERAKH. (Nuclear Magnetic Resonance in Polymers). Slonin, I. Ya.; Lyubimov, A. N. Moscow, Izdatel'stvo Khimiya, 1966. 339p.

The most important results obtained in studies of polymers by the NMR method are compiled. The physical bases of the method are explained. Principles of NMR spectrometers, their recording capacities, and the taking of the spectra are described. Relations and formulas necessary for the processing of experimental data are given. In sequence, the study of the structure of polymers; the study of molecular motion and chemical processes in polymers; and the use of NMR for quantitative analysis are considered. (748 references) (tr-auth)

27988 INTEGRALY PEREKRYVANIYA I PROBLEMA EFFEKTIVNYKH ZARYADOV. TOM I. (Overlapping Integrals and the Problem of Effective Charges. Volume 1). Batsanov, S. S.; Zvyagina, R. A. Novosibirsk, SSSR, Izdatel'stvo Nauka Sibirskoe Otdelenie, 1966. 388p.

Formulas and programs were developed for calculation of overlapping integrals with consideration of the problems of effective charges in problems of chemical bonds. The overlapping integrals were calculated for all combinations of atoms of the elements of the I to VI periods of the periodic table and tabulated in a form suitable for use in physical chemistry studies. (J.S.R.)

27989 CONVERSION OF U_3O_8 TO UC. Strausberg, S. (to U. S. Atomic Energy Commission). U. S. Patent 3,320,034. May 16, 1967.

A process for preparing UC of controlled C content comprises reacting U_3O_8 with C in a molar ratio of approximately 1 to 10 in a two-stage carbothermic reduction process. The first stage reaction temperature is maintained below 1050°C, and the second stage reaction temperature is maintained above 1100°C. (AEC)

27990 STABILIZED FLUIDIZED BEDS. (U. S. Atomic Energy Commission). British Patent 1,070,806. June 1, 1967. Priority date Feb. 28, 1964, United States.

A fluidized bed reactor having gas inlet and outlet means and gas pumping means for passing gaseous fluidized medium through the bed includes means for generating a high voltage to stabilize the fluidized bed. First and second electrodes are positioned one above and one below the bed and are connected to high-voltage generating means. A voltage is passed through the electrodes sufficient to form a corona discharge in the medium. (B.L.M.)

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Refer also to abstracts 28508, 28743, 29359, and 29850.

27991 (AAEC/TM-360) A FIVE YEAR PROGRAMME FOR RADIOISOTOPE PRODUCTION AT THE RESEARCH ESTABLISHMENT. Boyd, R. E.; Engelbert, U.; Gregory, J. N.; Miles, G. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov. 1966. 24p. Dep.

Plans for radioisotope production at Lucas Heights over the period 1966-71 are summarized, and indications are given as to how these are based on present trends of demand for radioisotopes. The program is discussed in terms of available staff and facilities; while some small staff increases will be required, the facilities presently being commissioned should be adequate over this period. (auth)

27992 (AERE-R-5434) PRODUCTS OF THE RADIATION INITIATED SULPHOXIDATION OF DODECANE. Hills, P. R.; Spindler, M. W. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Mar. 1967. 26p. Dep. CFSTI. UK 3s. 6d.

The irradiation of dodecane in the presence of sulphur dioxide and oxygen resulted in the formation of dodecanepersulphonic acid by a chain process. This material was unstable and underwent further reaction to form a sulphoxidation oil of complex composition. The properties of the oil which are relevant to its potential use as an intermediate for the preparation of a biodegradable detergent were established. The main components of the oil were separated and identified. Dodecane mono- and disulphonic acids together with sulphuric acid comprised over 90% of the crude product, and evidence has been obtained for other minor components formed during gamma irradiation or subsequent processing. (auth)

27993 (BMwF-FBK-67-24) ABBAU UND VERZWEIGUNG VON POLYVINYLACETAT IN LOESUNG UNTER DER EINWIRKUNG VON $^{60}Co-\gamma$-STRAHLEN. (Degradation and Branching of Polyvinyl Acetate in Solution Under the Influence of $^{60}Co-\gamma$-Irradiation). Schamberg, E. (Technische Universitaet, Berlin (West Germany)). Mar. 1967. 14p. (In German). Dep.

Linear polyvinyl acetate possessing an approximately random molecular weight distribution was γ irradiated in acetone solution at various concentrations. By light scattering and viscosity measurements it was found that at concentrations below the critical concentration for gel formation the polymer is crosslinked to a certain extent besides the predominant degradation of the main chain. In accordance with the previously developed theory of simultaneous crosslinking and degradation the ratio of the specific degradation and crosslinking densities p_0/q_0 was increased with decreasing polymer concentration and surpassed the value 2 at the critical concentration. (auth)

27994 (BNL-11344) GAMMA RADIATION INDUCED IONIC VINYL POLYMERIZATION. Metz, Donald J. (Brookhaven National Lab., Upton, N. Y.); Ballantine, David S. (Division of Isotopes Development (AEC), Washington, D. C.). [1966]. 40p. (CONF-670516-1). Dep. CFSTI.

From Polymer Science, Current Concepts and Civic Applications Conference, New York, N. Y.

Experimental conditions for the radioinduced ionic polymerization of vinyl monomers, such as styrene, are described. Extreme measure to purify and dry the monomers and all glassware is stressed. Kinetics of the ionic polymerization are given. Molecular weight dependence on dose rate and nature of inhibitors are also discussed. (P.C.H.)

27995 (NP-16755) ANNUAL REPORT [ON NUCLEAR PHYSICS], 1966. Basu, J.; Ghosh, D. K. (eds.) (Saha Inst. of Nuclear Physics, Calcutta (India)). Jan. 1967. 136p. Dep.

Research programs and progress in nuclear physics, biophysics, radiation chemistry, plasma physics, and nuclear chemistry are summarized. (D.C.W.)

27996 (RRL-2310-199) QUARTERLY REPORT [ON RADIATION RESEARCH], JANUARY 1-MARCH 31, 1967. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). Apr. 19, 1967. Contract AT(30-1)-2310. 15p. Dep. CFSTI.

Developments are reported for studies on: solute concentration dependence of ion scavenging processes in the radiolysis of hydrocarbon solutions; Hg ($^1P_1$) photosensitized decomposition of cyclobutane; effects of high intensity in the photodecomposition of ethane; reactions of 0^- with alcohols in gas phase radiolysis; ESR spectra with SeF_6 as matrix; theory of structure of the PF_4 radical; electronic structure of NCN and CO_2; dose and concentration dependence of hydrogen transfer in cyclopropane-hexane mixtures; electron scavenging in irradiated cyclohexane solutions; pulse radiolysis of the reaction of OH radicals with nitromethane; pulse radiolysis of ice; radioinduced hydroxylation of nitrobenzene in dilute aqueous solution; and Meisenheimer complexes. (P.C.H.)

27997 (NASA-TT-F-481) CHANGES IN THE KINETIC PROPERTIES OF THE THERMAL DECOMPOSITION OF $KMnO_4$ AS A RESULT OF ^{60}Co-IRRADIATION. Protashchik, V. A.; Erofeev, B. V. Translated from Dokl. Akad. Nauk Belorussk. SSR, 10: 658-61(1966). 9p. CFSTI.

Quantitative aspects of changes in the kinetic behavior of the thermal composition of alkali metal permanganates, specifically $KMnO_4$, under irradiation by ^{60}Co are discussed, with consideration of the influence of biographic factors such as dispersion, surface area, impurities, and fabrication flaws. The effect of irradiation on the kinetics of thermal decomposition consists mainly in an increase of the constant k in the topokinetic equation $\alpha = 1 - \exp(-kt^n)$, meaning that this effect leads primarily to the development of new potential centers representing foci for growth of solid product nuclei. (auth)

27998 COMPARATIVE DEGRADATION OF VARIOUS STARCHES BY γ RAYS, ELECTRON RADIATION, AND ULTRASONICS. Samec, M. (Chemical Inst. "Boris Kidric", Ljubljana, Yugoslavia). Staerke, 13: 283-92(1961). (In German).

Various types of starches including sorghum starch, marantha starch, tapioca starch, waxy maize starch, waxy sorghum starch, and high-amylose maize starch were irradiated with 2×10^6 Rep of γ irradiation, given at rates of 100,000 and 200,000 Rep/hr, with electron irradiation, or with 14-kHz ultrasonic radiation. These starches were converted to soluble starch by the irradiation treatments. Charts and tables are presented to illustrate effects of the treatments on various characteristics of the starches. These include the appearance, viscosity, % maltose reduction, pH, I uptake %, cleavage with β-amylase, molecular weight, % permeable through collodion, electrodialysis properties, % diminution in electrodialysis, sol pH, sol I uptake %, sol P_2O_5 %, gel pH, and gel P_2O_5%. The results indicated that consideration should be given to modification of the structure postulated for amylopectin. The form of the amylopectin molecule probably should be considered to be more linear, with a main chain to which branched globular fractions are attached on side chains. Its properties would account better for the changes in colors given with I, and for the colloid-chemical changes observed after irradiation and chromatograph. (BBB)

27999 EFFECT OF NEUTRON RADIATION ON STARCH (RADIOACTIVE STARCH). Samec, M. (Chemical Inst. "Boris Kidric", Ljubljana, Yugoslavia). Staerke, 15: 83-5(1963). (In German).

Potato, corn, and wheat starches were irradiated with 9×10^{14} n/cm^2 and, for comparison, with 2×10^6 Rep of γ radiation. The products formed were compared with unirradiated starch with respect to concentration, viscosity, % maltose reduction values, % I binding, pH, β-amylase splitting, average molecular size, % collodion permeability, electrodialysis properties, sol concentration %, % nonprecipitable by electrodialysis, % I binding of the sol, sol pH, gel concentration %, % I binding of gel, gel pH, and gel P_2O_5. Both types of irradiations produced peptization, but the effects of the γ irradiation were greater. Particle size was reduced, colloidal diffusibility increased, molecular size decreased, and internal frictional forces decreased. The fraction precipitable by electrodialysis decreased, and the sol fraction increased. Acidity and reducing properties increased somewhat. The I-binding capacity of the nonfractionated solutions decreased, suggesting shortening of the glucose chains. The unbranched glucose chains were also shortened, as the reduction in I binding of the sol form indicated. In potato starch the I binding of the amylopectin fraction decreased, indicating shortening or reduction in the side chains. In wheat starch I binding increased, and β-amylase reactivity was increased. Most of the P was retained after irradiation. The neutron-irradiated starches became radioactive. Measurements indicated that this was due to the P and C in the starches. (BBB)

28000 EFFECT OF NITROUS OXIDE ON THE RADIOLYSIS OF LIQUID METHANOL WITH THE RECOILS FROM THE ^{10}B(n,α) Li REACTION. Imamura, Masashi; Seki, Hiroshi (Inst. of Physical and Chemical Research, Tokyo). Bull. Chem. Soc. Jap., 40: 1116-18(May 1967).

Liquid methanol containing trimethyl borate and nitrous oxide was irradiated with thermal neutrons from a nuclear reactor. In contrast to the marked effect on the γ-radiolysis yields, nitrous oxide had a little effect on the recoil radiolysis yields from methanol, and nitrogen yield was as low as 0.2 in G units. These results indicate that the yield of the solvated electron in the recoil radiolysis of methanol is about one tenth of that in the γ radiolysis. (auth)

28001 STUDIES OF THE EPR SPECTRA OF SOME IRRADIATED TWO-COMPONENT GLASSES. Sidorov, T. A.; Tyul'kin, V. A. Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 2033-8(Nov. 1966). (In Russian).

The EPR spectra of γ-irradiated melted quartz and two-component alkali-silicate glass were studied. The centers in melted quartz and in crystalline quartz were identical. In alkali-silicate glass centers were bound by holes captured at the end of unbridged oxygen atoms and centers bound with electrons captured by alkali metal ions. Some glasses exhibited a doublet structure of hole bands. The possible centers with the doublet band structure are discussed. (R.V.J.)

28002 RADIOLYSIS OF SOLID L-α-ALANINE. Minegishi, Atsuko; Shinozaki, Yoshiharu; Meshitsuka, Gisuke (Tokyo Metropolitan Isotope Research Center). Bull. Chem. Soc. Jap., 40: 1271-2(May 1967).

The radiolysis of solid L-α-alanine was studied in comparison with that of glycine. From an ESR study of the radicals from the irradiation of normal and deuterated L-α-alanine at 77°K, a radical containing one α-proton and one β-proton, a precursor of $CH_3\dot{C}HCO_2^-$, was found. (D.H.M.)

28003 ELECTRON SPIN RESONANCE STUDIES OF FUNDAMENTAL PROCESSES IN RADIATION AND PHOTO-CHEMISTRY. PART 4. γ-IRRADIATED POTASSIUM ALKYL SULPHATES BETWEEN 77 AND 300°K. Ayscough, P. B.; Roy, A. K. (Leeds Univ., Eng.). Trans. Faraday Soc., 63: 1106-14(May 1967).

The effects of ionizing radiation on potassium methyl and ethyl sulphates was examined, using electron spin resonance to identify the trapped paramagnetic species. After γ irradiation at 77°K the radicals $\dot{C}H_2OSO_3^-$ and $CH_3\dot{C}HOSO_3^-$ predominate in the methyl and ethyl compounds respectively, and some SO_3^- is seen. Above 200°K only SO_3^- occurs; its identity was confirmed by an analysis of the ^{33}S hyperfine interaction. Mechanisms for the radiolysis are discussed. (auth)

28004 RADIATION POLYMERIZATION OF CRYSTALLINE TRITHIANE. Carazzolo, G.; Mammi, M.; Valle, G. (Centro Ricerche Resine, Castellanza, Italy). Makromol. Chem., 100: 295-6(1967).

By solid-state radioinduced polymerization of trithiane (orthorhombic, with a = 7.668, b = 7.003, c = 5.285 Å), twinned crystals of hexagonal polythiomethylene (PTM) (a = 5.07, c = 36.52 Å) were obtained. It was demonstrated that the solid-state polymerization takes place along the 2 diagonals of the trithiane a,b plane, which are 84°48′ and 95°12′ apart, thus giving rise to PTM twinned crystals having their c axes parallel to the trithiane [110] and [1$\bar{1}$0] directions. Some new weak reflections, observed on long exposure photographs, which may not be compatible with this polymerization model are examined. All the new spots were explained by 2 small twinned crystals, having their c axes parallel to the c trithiane (rotation) axis and their a axes parallel to the trithiane [110] or [1$\bar{1}$0] axes. Hence, it was concluded that the radioinduced solid-state polymerization of trithiane occurs mainly along the 2 diagonals of the trithiane a,b plane and, in a small amount, in the direction of the trithiane c axis. (BBB)

28005 CRYSTAL STRUCTURE OF ORTHOHOMBIC POLYSELENOMETHYLENE. Carazzolo, G.; Mammi, M. (Centro

Ricerche Resine, Castellanza, Italy). Makromol. Chem., 100: 28-40(1967).

A crystalline modification of polyselenomethylene was obtained by γ-induced solid-state polymerization of triselenane. The twinned crystals of this modification proved to be orthorhombic with the space group $P2_12_12_1$ and a = 5.37 Å, b = 9.03 Å, c = 4.27 Å. The reciprocal orientation of the polymer crystals was also defined. The 2 twinned polymer unit cells have their x axes parallel to the triselenane [hh0] and [hh̄0] axes, and their x axes both parallel to the triselenane z axis. An x-ray analysis was also made of the crystal structure of the cyclic trimer of selenoformaldehyde, 1,3,5-triselenane, and of hexagonal polyselenomethylene, both obtained by reacting hydrogen selenide with formaldehyde in the presence of hydrochloric acid. On the basis of the structural features of the hexagonal polymer (HPSeM) and of the similarities of the x-ray data of the 2 crystalline modifications, it is suggested that the unit cell of the orthorhombic polymer (OPSeM) is crossed by 2 helical chains with their axes parallel to c and with 2 $-CH_2Se-$ units and 1 turn of the helix comprised in the 4.27 Å repeat. The OPSeM should therefore have, as the orthorhombic polyoxymethylene (OPOM), a chain conformation similar to the model with square projection indicated by the symbol B_4 in the Bunn notation. These results were confirmed by the detailed x-ray analysis of the OPSeM structure. (BBB)

28006 BIPHENYL RADIOLYSIS. Sweeney, Michael A.; Hall, K. Lynn; Bolt, Robert O. (Chevron Research Co., Richmond, Calif.). Contracts AT(11-1)-174; AT(04-3)-248. J. Phys. Chem., 71: 1564-71(May 1967).

Biphenyl was irradiated with ^{60}Co γ rays and with 38-MeV helium ions to study its radiolysis. The major products were hydrogen, quaterphenyls, hydrogenated polyphenyls, and other polymers. For ^{60}Co irradiation at 82°C, $G(H_2) = (7.22 \pm 0.09) \times 10^{-3}$, $G(C_2H_2) = (0.542 \pm 0.030) \times 10^{-3}$, and G(→residue) = 0.226 ± 0.009. For He^{2+} irradiation at 82°C, $G(H_2) = (18.8 \pm 0.1) \times 10^{-3}$, $G(C_2H_2) = (2.93 \pm 0.03) \times 10^{-3}$, and G(→residue) = 0.356 ± 0.008. Similar data are given for 27, 180, and 260° ^{60}Co irradiations and for 180°C He^{2+} irradiations. Many products were formed in low yield and the approximate G values are given. Product yields were larger at high temperatures and for more highly ionizing radiation and were lower from solid-phase irradiations. There was no apparent effect of dose or of dose rate. The distribution of products indicates the important participation of phenylcyclohexadienyl radicals and biphenylyl radicals in the radiolysis scheme. (auth)

28007 PULSE RADIOLYSIS OF AQUEOUS EOSIN. Chrysochoos, J.; Ovadia, J.; Grossweiner, L. I. (Michael Reese Hospital and Medical Center, Chicago). J. Phys. Chem., 71: 1629-36(May 1967).

A pulse radiolysis investigation of aqueous eosin (S) showed that the initial products are semireduced eosin (R) [$e^-_{aq} + S \rightarrow R$ ($k \geq 5 \times 10^9$ M^{-1} sec^{-1})], semioxidized eosin (X) [$OH + S \rightarrow OH^- + X$ ($k = (1.4 \pm 0.4) \times 10^{10}$ M^{-1} sec^{-1})], and a long-lived "red product" attributed to the H and OH ring-addition products. In deaerated solutions the dye radicals decay predominantly by the back reaction $R + X \rightarrow 2S$ ($k \cong 8 \times 10^8$ M^{-1} sec^{-1}), with permanent bleaching due to $R + R \rightarrow S +$ leuco base ($k = (4.2 \pm 0.9) \times 10^6$ M^{-1} sec^{-1}) and $X + X \rightarrow$ products ($k = (2.0 \pm 0.5) \times 10^8$ M^{-1} sec^{-1}). Measurements made in the presence of H_2O_2, to convert e^-_{aq} to OH, and OH scavengers led to the results $S + CH_2\dot{C}HOH \rightarrow R + CH_3CHO$ ($k = (1.1 \pm 0.2) \times 10^9$ M^{-1} sec^{-1}) and $S + CO_2^- \rightarrow R + CO_2$ ($k = (2.5 \pm 0.5) \times 10^8$ M^{-1} sec^{-1}). The results were compared with previous flash photolysis measurements and predictions of the Debye equation for encounter-limited reactions. (auth)

28008 PULSE RADIOLYSIS STUDIES IN OXYGENATED ALKALINE SOLUTIONS. Czapski, Gideon (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-1)-Gen-16. J. Phys. Chem., 71: 1683-8(May 1967). (BNL-10548).

The reaction kinetics of transient species in aqueous oxygenated solutions was investigated by pulse radiolysis techniques. The decay of O_3^- was followed at 4300 A. The dependence of the yield and the decay rate was measured over the pH range from 12.7 to 14 as a function of concentrations of oxygen, N_2O, and H_2O_2. The decay was first order under all conditions and the O_3^- was stabilized by oxygen; $\tau_{\frac{1}{2}} = 11.4 \times [O_2]$ sec. The decay of the absorption at 2400 A was found to be much slower than at 4300 A, indicating that at these wavelengths different species are the absorbing intermediates. The possible identity of the species and the mechanism are discussed. (auth)

28009 THE γ RADIOLYSIS OF LIQUID 2-PROPANOL. III. CHAIN REACTIONS IN ALKALINE SOLUTIONS CONTAINING NITROUS OXIDE. Sherman, Warren V. (Soreq Nuclear Research Centre, Yavne, Israel). J. Phys. Chem., 71: 1695-1702(May 1967).

A study was made of the γ radiolysis of solutions of potassium hydroxide and nitrous oxide in 2-propanol. The major products identified were nitrogen, methane, acetone, and potassium acetate. The exceptionally high product yields ($G(N_2) > 10^3$ was observed) indicated a chain mechanism. Yields were determined as a function of dose, dose rate, and concentrations of potassium hydroxide and nitrous oxide. The observed dependence of yields on the reciprocal of the square root of the dose rate is consistent with bimolecular termination being of major importance. The yields were independent of the potassium hydroxide concentration when [KOH] > 2×10^{-2} M, but were proportional to the concentration of nitrous oxide. Large yields of hydrogen ($G(H_2) \approx 20$) were noted at certain nitrous oxide concentrations. Evidence is presented to support the suggestion that the 2-propoxide radical anion (I) is the chain carrier and that the propagation steps for the formation of nitrogen and acetone involve the reactions: $Me_2\dot{C}O^-$ (I) + $N_2O \rightarrow Me_2CO + N_2 + O^-$; $O^- + Me_2CHOH \rightarrow OH^- + Me_2\dot{C}OH$; $Me_2\dot{C}OH + Me_2CHO^- \rightarrow I + MeCHOH$. Inhibition and retardation of the chain reaction were observed in the presence of a number of organic solutes. (auth)

28010 RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS OF ETHANOL. Seddon, W. A.; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Phys. Chem., 71: 1914-18(May 1967). (BNL-10795).

Hydrogen yields from γ rays on neutral solutions of ethanol and oxygen were determined over wide ranges of concentration. The results indicated a simple competition between O_2 and EtOH for an H atom, generated with a yield $G_H = 0.6$; the properties of this radical did not change at very low oxygen concentrations. In acid solutions, where H is generated with G = 3.3, the same competition was found. Oxygen-free solutions containing ethanol and hydrogen peroxide showed a chain reaction under γ rays, the kinetics of which were found to be in agreement with the anticipated free-radical mechanism. The reaction was studied with intermittent x rays ("rotating sector" method) and an absolute rate constant obtained for the reaction of ethanol radicals with H_2O_2. The results are all consistent with values for the primary radical yields of $G_{e^-} = G_{OH} = 2.25 \pm 0.05$. These values are significantly lower than those deduced from some other systems and the reasons for the discrepancies are not completely understood. (auth)

28011 YIELD OF THERMAL ETHYL RADICALS FROM THE RADIOLYSIS OF ETHYLENE-CYCLOHEXANE SOLUTIONS. McCrumb, J. L.; Schuler, Robert H. (Mellon Inst., Pittsburgh). J. Phys. Chem., 71: 1953-5(May 1967). (RRL-2310-191).

In the gamma radiolysis of ethylene-cyclohexane solutions dilute iodine was used to scavenge totally the product ethyl radicals and thus gave a measure of the concentration dependence of the absolute yield for their formation. The experiments were carried out at sufficiently low concentrations so that the iodine quantitatively scavenged the alkyl radicals but did not interfere in either the abstraction ($H\cdot + RH \rightarrow H_2 + R\cdot$) or the addition ($H\cdot + C_2H_4 \rightarrow C_2H_5$) reactions of the hydrogen atoms. The rate constant ratio was found to be 0.0034 which was almost identical with that reported by Holroyd (0.0037), but the hydrogen atom yield was somewhat lower than the value obtained by him. (D.H.M.)

28012 MEASUREMENT OF THE MEAN ENERGY NECESSARY TO CREATE AN ION PAIR IN SOME LIQUID DIELECTRICS. Mathieu, Jacques; Blanc, Daniel; Caminade, Pierre; Patau, Jean-Paul (Faculte des Sciences, Toulouse). Compt. Rend., Ser. A and B, 264: 751-4(Mar. 6, 1967). (In French).

By irradiation in a special cell with plain electrodes, the curve of the ionization current was constructed as a function of the electric field up to 200 $kVcm^{-1}$. The saturation current or the mean energy necessary to create an ion pair was deduced by adjustment of the theoretical Jaffe curve with the experimental curve obtained. The results are given for some alkanes and aromatic hydrocarbons (n-hexane, n-octane, 3-methylheptane, 3-ethylhexane, 2,3-dimethylhexane, 3-ethyl-2-methylpentane, 2,2,4-trimethylpentane, cyclohexane, methylcyclohexane, benzene, toluene, and carbon tetrachloride). (tr-auth)

28013 RADIOISOTOPE PRODUCTION AND PROCESSING. Rahman, Matiur (Atomic Energy Centre, Dacca, Pakistan). Nucleus (Lahore), 3: 66-8(July-Sept. 1966).

Development of an isotope production program for Pakistan using an available 5 MW research reactor is announced. Standards for control and administration of the program are discussed. (P.C.S.)

28014 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XIX. SOLID STATE POLYMERIZATION IN BINARY SYSTEMS. Hardy, Gyula; Varga, Jozsef; Nagy, Gabor; Varga, Eszter; Sara, Laszlo (Polytechnical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 52: 219-28(1967).

The influence of benzoquinone was investigated in solid-state polymerization of acrylamide, trioxane, and 3,3-bis(chloromethyl)

oxetane. The solid-state polymerization of trioxane in the presence of succinimide and naphthalene was also studied. These binary systems are characterized by formation of simple eutectics. A comparison of the effect of benzoquinone and added inert compounds proved the free radical mechanism of the solid-state polymerization of acrylamide but in the case of trioxane and 3,3-bis(chloromethyl)oxetane the mechanism of the polymerization was indeterminable by use of benzoquinone. An investigation of the system trioxane–naphthalene revealed the important role of the conditions of crystallization in the polymerization of binary systems. (auth)

28015 THE RADIATION INDUCED ANTI-MARKOWNIKOFF ADDITION OF HYDROGEN BROMIDE TO ALPHA-OLEFINS. McFarling, J. L.; Kircher, J. F. (Battelle Memorial Inst., Columbus, Ohio). Int. J. Appl. Radiat. Isotop., 18: 345-8(June 1967).

The radioinduced addition of HBr to alpha-olefins from propene to octene, was investigated from –79 to +25°C. The addition was predominately abnormal, or anti-Markownikoff, giving rise to the primary bromide which constituted well over 90 percent of the product in most cases. The addition was presumably by a long-chain mechanism with G-values for the addition product of the order of 10^3 in the gas phase and 10^5 in the liquid phase. (auth)

28016 ENERGY STRUCTURE OF A CASCADE OF COLLISIONS OF IDENTICAL PARTICLES IN A DECELERATING MEDIUM. Lenchenko, V. M.; Starodubtsev, S. V. Dokl. Akad. Nauk SSSR, 172: 80-2(Jan. 1, 1967). (In Russian).

The energy spectrum of the cascade particles was determined as a function of the energy of the initial cascade particles and of the decelerating ability of the medium. The energy spectrum of the cascade is characterized by a certain function expressing the total range of the cascade particles of a given species having an energy in a given interval. An integral equation is derived for this function with account taken of the cascade multiplication. This equation differs in principle from a similar equation derived earlier (Paper at the First Conference on Radiation Physics of Solids, October, 1965, Kiev) for a cascade of atom–atom collisions, and makes it possible to obtain a more adequate approximation than before. In particular, it allows for the energy lost by the cascade particles for long-rate collisions. The integral equation is used to calculate the energy distribution function of the electrons in a cascade of electron–electron collisions in a decelerating medium. It is shown that one electron with energy $E = 5 \times 10^5$ eV for a medium whose average ionization potential is close to 1 eV produces 1.2 electrons with energy 10^5 eV, 70 electrons with energy 10^3 eV, and 4×10^3 electrons with energy 10^2 eV. The accuracy of the method depends strongly on the accuracy with which the ionization potential is known. (ATD)

28017 EFFECT OF ELECTRIC FIELD ON RADIOLYSIS OF LIQUID HYDROCARBONS. Gusynin, V. I.; Tal'roze, V. L. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR, 170: 135-8(Sept. 1, 1966). (In Russian).

Straight-chain saturated hydrocarbons (12, 14, and 16 carbon atoms) were irradiated with 1.6-MeV reactor electrons in an electric field at 20 to 25°C. Decomposition was observed by continuous recording of the H_2 produced as shown by an on-line mass spectrometer. When n-tetradecane was irradiated at 10^{17} eV/cc·sec (total dose no greater than 20 MRADS), application of an electric field (maximum 3×10^4 volts/cm in the interelectrode space of the irradiation chamber) increased the rate of hydrogen formation. When the electric field was discontinued, the rate returned to normal. Because of the conditions used, this effect is considered not to be due to impurity in the liquid, decomposition in the gas phase, ordinary volatilization, or change in the shape of the irradiated liquid layer. The magnitude of the effect was independent of the polarity of the applied field. Increase of the potential in the range 0.5 to 3 kV increased the percentage of hydrogen formed, while an increase in the radiation dose in the range 10^3 to 10^5 RADS/sec decreased the percentage of hydrogen. (TTT)

28018 THE REACTOR PRODUCTION OF ^{84}Rb FROM STRONTIUM. Hupf, H. B.; O'Brien, H. A. Jr. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Int. J. Appl. Radiat. Isotop., 18: 417-20(June 1967). (ORNL-P-2661).

The production of ^{84}Rb by the ^{84}Sr(n,p)^{84}Rb reaction was measured, and millicurie amounts were found to be readily obtainable from isotopically enriched ^{84}Sr targets. The fission-neutron cross section for this reaction is reported as 0.0056 barn. The ^{84}Rb was separated from the strontium targets by a previously unreported ion exchange method, utilizing Bio-Rex-70 cation exchange resin. The ^{84}Rb products were found to be free of detectable radiocontaminants. (auth)

28019 PULSE RADIOLYSIS OF BENZOQUINONE AND HYDROQUINONE. SEMIQUINONE FORMATION BY WATER ELIMINATION FROM TRIHYDROXYCYCLOHEXADIENYL RADICALS. Adams, G. E.; Michael, B. D. (Mt. Vernon Hospital, Northwood, Eng.). Trans. Faraday Soc., 63: 1171-80(May 1967).

A number of transient free-radical spectra produced during the pulse radiolysis of benzoquinone and hydroquinone were observed and characterized. The semiquinone radical and radical-anion were produced directly by reactions of e_{aq}^- and H atoms with benzoquinone and also by the unimolecular elimination of water from trihydroxycyclohexadienyl radicals. The latter species arise directly by OH addition to hydroquinone. The extinction coefficients of the various species and the reaction rate constants for their formation and decay were measured. The equilibrium constant for the benzsemiquinone radical and radical-anion equilibrium is 10^{-4} M. (auth)

28020 BEHAVIOR OF THE EXTRACTANT TBP + CCl_4 UNDER IRRADIATION. Kurtepov, M. M.; Pushlenkov, M. F.; Zil'berman, B. Ya.; Gryaznova, A. S.; Efremova, T. I. Radiokhimiya, 9: 32-7(1967). (In Russian).

It was established that the yield of radiolytic products from the extractant TBP–CCl_4, DBT and Cl^-, depends nonlinearly on the composition of the organic phase. The yield depends strongly on the presence in the system of aqueous phases (in laminar or dispersed state) and on the composition of the system. The character of the radical interaction in the system is discussed. (tr-auth)

28021 DECOMPOSITION OF BENZENE AND DEUTERATED BENZENES UNDER ELECTRON IMPACT. Jennings, K. R. (Univ. of Sheffield, Eng.). Z. Naturforsch., 22a: 454-9(Apr. 1967).

Metastable transitions were observed in the mass spectra of benzene, hexadeutero-benzene, 1,4-dideuterobenzene, and 1,3,5-trideuterobenzene using a double-focusing mass spectrometer. Decomposition maps were obtained for each substance and decomposition reactions leading to the production of all significant fragment ions were suggested. Metastable transitions of several doubly charged species were found. Loss of identity by the H and D atoms of the partly deuterated benzenes was observed in metastable transitions in their mass spectra, indicating that rapid isomerization occurs before fragmentation. (auth)

28022 RADIATION-INDUCED REACTIONS WITH CELLULOSE. III. KINETICS OF STYRENE COPOLYMERIZATION IN METHANOL. Dilli, S.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). J. Appl. Polymer Sci., 11: 859-70(June 1967).

The kinetics of radioinduced grafting of styrene to cellulose in methanol were studied in air at dose rates of 0.007, 0.014, and 0.078 MRAD/hr in ^{60}Co and spent fuel-element facilities. The variables affecting rate of grafting include monomer concentration, radiation-dose rate, and total dose. Grafting reaches a maximum at 60 to 70 vol% methanol in styrene. Results are interpreted in terms of possible grafting mechanisms, including charge-transfer intermediates; however, a complete mathematical treatment of the data is not possible at present because of the absence of appropriate swelling data for cellulose in mixtures of styrene and methanol. Poor grafting observed in solutions of up to 10% monomer is attributed to radical scavenging (predominantly from the solvent) by the monomer leading to the formation of scavenged products including homopolymer. Rate of grafting falls off for solutions above 80 to 90% monomer concentration and radical scavenging by monomer radicals is again postulated to account for the observed behavior. (auth)

28023 STUDY OF RADIATION-INDUCED GRAFT POLYMERIZATION OF VINYL MONOMERS TO CELLULOSE BY INFRARED SPECTROSCOPY. I. CELLULOSE–POLYACRYLONITRILE COPOLYMERS. Imrisova, D.; Maryska, S. (State Textile Research Inst., Brno). J. Appl. Polymer Sci., 11: 901-7(June 1967).

Infrared spectral analysis was applied to the study of cotton–polyacrylonitrile copolymers prepared by using the preirradiation method. The degree of grafting was determined from the absorption at 2249 cm^{-1}, which is characteristic of the polyacrylonitrile spectrum, with an accuracy of ±1.5%. (auth)

28024 RADICALS PRODUCED BY GAMMA IRRADIATION THROUGH HYDROGEN ADDITION BY PYRIDINE AND DIAZINES IN ETHANOL SOLUTION AT 77°K. Chachaty, Claude; Forchioni, Alain (CEA-CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 264: 1421-4(Apr. 24, 1967). (In French).

The electron paramagnetic resonance spectra obtained after gamma irradiation at 77°K of pyridine and of the three diazines in solution in vitreous ethanol indicate the formation of radicals resulting from the addition of hydrogen on a nitrogen probably by means of anions produced by electron capture. (tr-auth)

28025 PERIODIC SYSTEM AND SUPERHEAVY ELEMENTS. Taube, Mieczyslaw (Univ. of Warsaw). Nukleonika, 12: 309-12 (1967).

The theory of using a nuclear reaction such as $^{242}Pu + {}^{22}Ne \rightarrow {}^{260}104 + 4_0n^1$ for the production of superheavy elements is discussed. Problems to be solved before such a reaction can be used are considered. (P.C.H.)

28026 DELAYED CURE WITH IONIZING RADIATION. Walsh, W. K.; Rutherford, Henry A. (North Carolina State Univ., Raleigh). Text. Res. J., 37: 89-93(Feb. 1967).

The use of β and γ radiation as the delayed step in a durable-press process for cotton fabric was investigated. Methylol acrylamide was reacted monofunctionally with cotton by a paddry-cure procedure, using acid catalysis. The fabric was washed free of all unreacted chemicals, made into garments, and crosslinked at room temperature with β rays from an electron accelerator. A pair of trousers 40 in. long could be cured in 2 to 5 sec, depending on the dose (~2 Mrad) desired. Corresponding doses from ^{60}Co source similar to the one used in the experiments described required 2 to 10 hr. A 3-sec curing time with β radiation would permit processing about 8000 garments in an 8-hr shift. An advantage of curing with radiation is that it can be done at room temperature. One disadvantage of radiation processing is its limitation to free-radical or ionic chain reactions. Fabrics treated with methylol acrylamide lack chlorine resistance and, after irradiation yellow slightly on standing or heating, perhaps because of double-bond formation during radical recombination. Treated, unirradiated fabrics have good wash-wear properties, however. (BBB)

28027 RADIOLYSIS OF METHANOLIC SOLUTIONS OF NITROUS OXIDE. Teply, J.; Habersbergerova, A. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 1608-10(Apr. 1967).

Results indicated that yields from the gamma radiolysis of methanolic solutions of nitrous oxide cannot be interpreted merely in terms of the role nitrous oxide plays as an electron scavenger. A more complex reaction mechanism, as yet undefined, is believed to be involved. (J.G.B.)

28028 ISOTOPE EFFECT IN NEUTRON-IRRADIATED n-BUTYL BROMIDE. Lal, A. (Banaras Hindu Univ., Varanasi, India). Curr. Sci. (India), 36: 288-9(June 5, 1967).

Success of a charged-plate technique adopted for observing the difference in isotopic yields in ^{80}Br and ^{82}Br produced under thermal-neutron irradiation with n-butyl bromide is reported. Results suggest a similarity in behavior of ^{80}Br and ^{82}Br recoil atoms on the charged electrodes. Although observations showed that the eventful life of the initially charged fragments determine on which electrode they will be deposited, the isotope effect can be visualized on either electrode in the case of n-butyl bromide. (P.C.S.)

28029 KINETIC SALT EFFECTS ON REACTIONS OF THE SOLVATED ELECTRON IN METHANOL. Buxton, G. V.; Dainton, F. S.; Hammerli, M. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 63: 1191-7(May 1967).

The effect of ionic strength on the rate constant ratios $k(e_s^- + Ag^+)/k(e_s^- + N_2O)$ and $k(e_s^- + H^+)/k(e_s^- + N_2O)$ was studied in the γ radiolysis of methanol. The different magnitudes of this effect in systems containing Ag^+ and H^+ ions emphasize the importance of ion size in the Bronsted-Bjerrum treatment of ionic reactions in this solvent. The data presented are consistent with the solvated electron in methanol having unit negative charge and an effective diameter of 5 Å. (auth)

28030 DOUBLE-RESONANCE STUDIES OF THE CONFORMATIONS OF THE FREE RADICAL IN IRRADIATED ALPHA-AMINOISOBUTYRIC ACID. Wells, James W.; Box, Harold C. (Roswell Park Memorial Inst., Buffalo). Contract AT(30-1)-3558. J. Chem. Phys., 46: 2935-8(Apr. 15, 1967). (NYO-3558-8).

The technique of fast-passage double resonance (ENDOR) was applied to the study of the three conformations of the free radical found when warming single crystals of α-aminoisobutyric acid, x-irradiated at 77°K. The ENDOR measurements, made at 4.2°K, allow absorption signals for the protons of the two methyl groups to be distinguished at all crystal orientations. Both methyl groups in the first two conformations and one group in the third conformation were found to have a single representative ENDOR line, indicating the group's rotation. The hyperfine tensors for these groups were found to depart from the generally assumed axial symmetry. The nonrotating methyl group in the last conformation permits an accurate determination of the parameters in the coupling equation $A = B_0 + B\cos^2\theta$. The experimental values are $B_0 = 3.2$ and $B = 123.3$ Mc/sec. (auth)

28031 HYDROGEN FORMATION IN THE RADIOLYSIS OF LIQUID METHANOL AND ETHANOL. Teply, J.; Habersbergerova, A. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 1350-8(Apr. 1967).

The mean values of the yields of hydrogen precursors formed in radiolysis of liquid methanol and ethanol were determined by means of the expressions comprising the kinetics of the scavenging of various hydrogen precursors by a solute. The precursors of hydrogen in the radiolysis of methanol were solvated electrons ($G_{e^-} = 1.1$), hydrogen atoms ($G_H = 1.6 - 2.7$), and unscavengeable hydrogen ($G_{H_3} = 1.6$) formed from hot hydrogen atoms or highly excited methanol molecules ($G_{H^\bullet} \geq 1$). Besides these hydrogen was formed directly ($G_{H_2,m} = 0.4 - 0.6$). At high concentrations of solutes further electrons (unsolvated) were scavenged: ($G_{e^-,add} = 0.5 - 0.8$). The known differences in the hydrogen yields in pure methanol ($G(H_2) = 4.3 - 5.4$) were probably caused by suppression of the formation of hydrogen atoms by some impurity. The yields of the hydrogen precursors formed in the radiolysis of ethanol were $G_{e^-_s} = 1.0$, $G_H \approx 2.6$, $G_{H_3} \approx 1.2$, and $G_{e^-,add} = 0.75$. The values of the rate constants $k_{(H+I_2)meth} \approx 2.9 \times 10^{10}$ l mol^{-1} s^{-1}, $k_{(e^-_s+I_2)meth} \lesssim 10^7$ l mol^{-1} s^{-1}, and $k_{(e^-_s+C_2H_5OH)eth} \approx 1.8 \times 10^4$ l mol^{-1} s^{-1} were derived. It was found that ferric chloride in protogenic solvents was unsuitable as a scavenger. (auth)

28032 γ-RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. I. AQUEOUS SOLUTIONS OF FERROUS SULFATE. Hentz, Robert R.; Farhataziz; Milner, David J.; Burton, Milton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 46: 2995-3000(Apr. 15, 1967). (COO-38-516).

The γ radiolysis of aerated and deaerated acid solutions of ferrous sulfate was studied at 20°C and applied pressures in the range from 0 to 6.34 kbar. Over the entire pressure range, $G(Fe^{3+}) = 8.1 \pm 0.1$ and $G(H_2) = 0.1$ in deaerated solutions containing 0.8N H_2SO_4, 1 mM NaCl, and 2 mM Fe^{2+}. Radiolysis of deaerated 0.8N H_2SO_4 solutions of dichromate gave $G(-O_2) = 0.78 \pm 0.02$ over the whole pressure range. It was concluded from such results, and observation of a similar pressure independence of $G(Ce^{3+})$ in the ceric sulfate dosimeter, that primary yields in water radiolysis are invariant as pressure varies from 0 to 6.34 kbar. In aerated ferrous solutions, $G(H_2)$, $G(Fe^{3+})$, and $G(-O_2)$ vary with pressure, ferrous concentration, and acid concentration in such a manner as to indicate an effect of pressure on the competition between the reactions $H + O_2 \rightarrow HO_2$ and $H + H^+ + Fe^{2+} \rightarrow Fe^{3+} + H_2$. Analysis of the results, for aerated ferrous solutions containing 0.8N H_2SO_4 and 1 mM NaCl, gives $k_1/k_2 \approx 1000$ at atmospheric pressure and $k_1/k_2 = 80$ at 6.34 kbar. The difference in activation volumes of the two reactions is obtained as $\Delta V_1^\ddagger - \Delta V_2^\ddagger = 11$ ml mole^{-1}. Estimation of $\Delta V_1^\ddagger \approx 2$ ml mole^{-1}, from the pressure dependence of water viscosity, gives $\Delta V_2^\ddagger \approx -9$ ml mole^{-1}. Such a value is not inconsistent with $H + Fe^{2+} \rightarrow FeH^{2+}$ as the rate-determining step in the second over-all reaction in 0.8N $HESO_4$. (auth)

28033 PULSE-RADIOLYSIS STUDIES OF THE FORMATION OF TRIPLET EXCITED STATES IN CYCLOHEXANE SOLUTIONS OF NAPHTHALENE AND ANTHRACENE. Hunt, John W. (Univ. of Toronto); Thomas, J. K. J. Chem. Phys., 46: 2954-8 (Apr. 15, 1967).

The radiolysis of solutions of naphthalene and anthracene in cyclohexane and benzene was studied using 3- to 11-nsec pulses of 3-MeV electrons. The triplet states of the solutes were observed via their characteristic absorption spectra, while the excited singlet states were observed via their fluorescence. The rate of formation of most of the triplet state was less than one nanosecond; a small portion, however, did grow in with a half-life of 100 nsec. The possible mechanisms of production of the triplet state are discussed, and it is concluded that they are formed either directly from subexcitation electrons or from ion recombination. (auth)

28034 TRIFLUOROMETHYL, AND OTHER RADICALS, IN IRRADIATED SINGLE CRYSTALS OF TRIFLUOROACETAMIDE. Rogers, Max T.; Kispert, Lowell D. (Michigan State Univ., East Lansing). Contract AT(11-1)-1385. J. Chem. Phys., 46: 3193-9(Apr. 15, 1967). (COO-1385-17).

ESR spectra characteristic of the trifluoromethyl radical were obtained when single crystals of trifluoroacetamide were irradiated and observed at 77°K. The isotropic hyperfine splitting found was the same as that reported for the trifluoromethyl radical in solution. The anisotropic hyperfine splittings indicated that the radical is oriented in the lattice but can undergo rapid reorientation about the threefold axis at 77°K. The observed ^{19}F and ^{13}C hyperfine-splitting values provided evidence that the radical has essentially the same structure in the crystal as in solution with bond angles ($\angle$FCF) near the tetrahedral value. The $\cdot CF_2CONH_2$ radical was also found and evidence for a new radical $\cdot NH_2CO$ reported. (auth)

28035 γ-RADIOLYSIS OF TITANIUM TETRACHLORIDE SOLUTIONS. Loeffelholz, M.; Rucci, G.; Ruffino, C. (Donegani Istituto di Richerche, Novara, Italy). Energ. Nucl. (Milan), 14: 245-8(Apr. 1967).

The behavior of titanium tetrachloride-heptane solutions under gamma-irradiation was studied. The gamma source was a ^{60}Co facility of 4,300 Curie. Titanium tetrachloride was reduced, by the action of gamma rays, to an insoluble product that can be easily separated. Experiments were carried out at temperatures from 20 to 260°C, at a total dose of 2.0×10^{21} to 1.0×10^{23} eV, and

at a dose rate from 2.0×10^{17} to 1.5×10^{18} eV/g min; concentrations of $TiCl_4$ between 1 and 95% (by weight) were used. X-ray analysis of the products thus obtained showed three crystalline forms of $TiCl_3$, α, β, and γ. At relatively low temperatures the β form was obtained, while at temperatures higher than 150°C a mixture of the α, β, and γ was produced. The $G(TiCl_3)$ values were determined in a series of systematic assays, as a function of temperature, dose rate, total dose, and $TiCl_4$ concentration. (auth)

28036 USE OF AN ION SOURCE WITH IONIZATION BY ELECTRON IMPACT IN THE REGION OF AN INHOMOGENEOUS ELECTRIC FIELD FOR INVESTIGATION OF REACTIONS INDUCED BY COLLISIONS OF ELECTRONS AND IONS WITH MOLECULES. Karachevtsev, G. V.; Tal'roze, V. L. (Inst. of Chemical Physics, Moscow). Kinet. Kataliz, 8: 5-11(Jan.-Feb. 1967). (In Russian).

Experimental data obtained in a mass spectral investigation by means of ion sources in which ionization by electron collision is carried out in a strong electric field on thin metallic filaments are reported. During ionization of toluene, approximately half of all the ion fragments $C_7H_7^+$ were formed during a time greater than 10^{-9} sec. The greatest part of the decomposition was finished in a time less than 2.5×10^{-7} sec. The ion source with metallic filaments was used also as an ion trap for increasing the residence time of the primary ions in the ion source, which is advantageous in comparison with the usual ion sources during investigation of elementary processes. Evaluation of the velocity constants of the reaction $H_2^+ + H_2 \rightarrow H_3^+ + H$ and $N^+ + O_2 \rightarrow NO^+ + O$ agrees with data obtained by other methods. Data were obtained indicating the reaction of ions produced from propane with Kr. (tr-auth)

28037 COMMENTS ON THE PART PLAYED BY ADDITIVES IN RADIOLYSIS. Salikhov, K. M. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Kinet. Kataliz, 8: 206-8 (Jan.-Feb. 1967). (In Russian).

Quantum mechanical conditions were formulated under which localization of the excitation of molecules of the basic substance in the vicinity of admixtures appeared possible. Decomposition of the basic molecule during radiolysis appeared to arise principally near admixtures. (tr-auth)

28038 CATALYSIS ON AMMONIUM NITRATE RADIOLYSIS BY SEMICONDUCTING OXIDES. Nevostruev, V. A.; Zakharov, Yu. A. (Tomsk Polytechnic Inst., USSR). Kinet. Kataliz, 8: 210-12(Jan.-Feb. 1967). (In Russian).

The effect of additions of ThO_2, ZnO, NiO, and ZnO, mixed with Li_2O and Al_2O_3 on the radiolysis of ammonium nitrate under x irradiation in a vacuum was investigated. Data showed that the catalytic activity of the oxides investigated in the radiolysis process of NH_4NO_3 is correlated with the change of the electron yield function, ϕ, by which oxides having the smallest ϕ accelerated the radiolysis of NH_4NO_3 the most. The results showed that a comparatively small amount of additive produced the greatest effect on the rate of radiolysis. (tr-auth)

28039 SYNTHESIS OF INORGANIC IONITES WITH HIGH SELECTIVE CAPACITY. Karpova, I. F.; Kazakov, E. V. Vestn. Leningr. Univ., No. 4, Ser. Fiz. Khim., No. 1, 136-7(Feb. 1967). (In Russian).

Ferrocyanide-organic ionites were obtained by precipitation of ferrocyanide in the matrix of ion-exchange resins. Examination of ionites showed a high ion-exchange capacity and stability to γ rays, acids, and alkalis, as well as cation and anion exchange properties. (auth)

28040 LABORATORY IRRADIATION SOURCE FOR RADIATION CHEMICAL RESEARCH. Drienovsky, P.; Kopunec, R.; Macesek, F.; Mikulaj, V.; Culka, D. (Komensky-Universitat, Bratislava). Chem. Zvesti, 21: 182-90(1967). (In Czech).

An irradiation device with a $^{90}Sr-^{90}Y$ source with an activity of 1,160 ± 116 mCi is described. The device is designed for radiation-chemical studies of materials in the liquid phase. The dose intensity of this source was determined with a Fricke dosimeter. The concentration of the trivalent iron was established by the spectrophotometric method by use of the molar extinction coefficient at a temperature of 26°C. The values obtained were 4560 l mol^{-1} cm^{-1} at 222.6 nm and 2187 l mol^{-1} cm^{-1} at 304.5 nm. These values were compared with the values obtained previously. In this irradiation device a dose intensity up to 1.5×10^{15} eV ml^{-1} sec^{-1} can be obtained. An approximate calculation of the dose intensity according to the semiempirical relation was given under the assumption that it is a point source so that this intensity was compared with experimentally determined values. (tr-auth)

28041 GAMMA RADIOLYSIS OF ALKALINE FERRATE(VI) SOLUTIONS. Kalecinski, Jerzy (Inst. of Structural Research Wroclaw). Rocz. Chem., 41: 661-8(1967).

The kinetics of radiation reduction of ferrate(VI) in concentrated KOH solutions were examined and the mechanism of this reaction is suggested. It was found that the hydroxyl radicals possess both reducing and oxidizing properties, but the latter are prevailing. (auth)

Radiochemistry

Refer also to abstracts 27897 and 28144.

28042 RADIOCHEMISTRY: TODAY'S PM TOOL FOR NUCLEAR POWER PLANTS. Stein, W. (Consolidated Edison Co., New York). Power, 111: 120-1(June 1967).

Uses of radiochemistry in the operation and maintenance of nuclear power plants are discussed. Fuel-element cladding defects, primary-coolant corrosion or erosion, boiler carryover, and many other malfunctions in nuclear-energy electric generation plants were discovered using radiochemical methods. Decontamination was also carried out more effectively by removing the radioactive contamination electrolytically using reverse electroplating. (P.C.S.)

28043 β PREPARATION OF XENON ONIUM DERIVATIVES BY ^{131}I β DECAY. Nefedov, V. D.; Toropova, M. A.; Levchenko, A. V. Radiokhimiya, 9: 138-9(1967). (In Russian).

The possibility of producing phenyl Xe perchlorate by β decay of ^{131}I in the compound $(C_6H_5)_2{}^{131}IClO_4$ was studied. Negative results on the accumulation of ^{131m}Xe in dilute aqueous solutions of diphenyl iodine perchlorate can be explained by one of two reasons: (1) the first part of the β conversion of ^{131}I does not occur in the molecule $(C_6H_5)_2{}^{131}IClO_4$ but in the cation $[(C_6H_5)_2{}^{131}I]^+$, which must lead to the formation of the unstable charged primary molecular ion $[(C_6H_5)_2{}^{131m}Xe]^{2+}$; (2) the β decay in the molecule $(C_6H_5)_2{}^{131}IClO_4$ in dilute aqueous solution leads to the formation of $(C_6H_5){}^{131m}XeClO_4$ and as a result of its hydrolysis in the water medium the unstable hydroxide $C_6H_5{}^{131m}XeOH$, whose decomposition leads to free Xe, is formed. (J.S.R.)

28044 CHEMICAL STATE OF ^{37}S RESULTING FROM THE REACTION $^{37}Cl(n,p)$ ON LITHIUM CHLORIDE IN THE SOLID STATE. Meyer, J. P.; Adloff, J. P. (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta, 6: 217(Dec. 1966). (In French).

Lithium chloride was irradiated in the solid state and the chemical state of ^{37}S resulting from the reaction $^{37}Cl(n,p)$ was compared with the chemical state of ^{37}S resulting from the irradiation of aqueous solutions of lithium chloride. The oxidation of $^{37}S^{2-}$ is less pronounced in the solid medium: 25% of the radiosulfur is in this form compared to only 15% in solution. The sum of the activities of the sulfate and sulfite fractions is the same for the solid state and the solution but the quantity of sulfate is lower in the solid target. The results show that the hot reactions with the solvent during the irradiation of solutions of lithium chloride intervene only to a small measure in the formation of radiosulfate fraction. (J.S.R.)

28045 OSNOVY RADIATSIONNO-KHIMICHESKOGO APPARATO-STROENIYA. (Principles of Design and Construction of Radio-Chemical Apparatus). Breger, A. Kh.; Vainshtein, B. I.; Cyrkus, N. P.; Gol'din, V. A.; Chepel', L. V. Moscow, Atomizdat, 1967. 498p.

A systematic review is given of the principles of radiochemical analysis, instrumentation, and large industrial radiation sources. Methods for computing basic characteristics and specifications of radiation sources and direct determination of absorbed radio-energy and results of numerical experiments using the Monte-Carlo methods are discussed. Problems of radiation shielding and personnel protection in large industrial radiochemical installations are also reviewed and analyzed. (605 references) (R.V.J.)

Separation Processes

Refer also to abstracts 27951 and 29969.

28046 (AERE-M-1884) PROCESSING IN LIMITED GEOMETRY. PART 15. A DEMONSTRATION OF PHYSICAL MIXING FOR OXIDE FUELS. Poole, K. R.; Wall, G. P. (Atomic Energy Research Establishment, Harwell (England)). May 1966. [Revised] Apr. 1967. 14p. Dep. CFSTI. UK 2s. 6d.

A small model powder mixer of the Loedige-type was used to blend UO_2/ThO_2 and UO_2/PuO_2. The homogeneity obtained in both systems was similar to that required in oxide fuels and matched that obtained in earlier work with UO_2/ThO_2 using a larger Loedige mixer and a continuous ribbon blender. The model blender can thus be used on small-scale experimental blends, and the results

can be directly related to the behavior to be expected from full-scale equipment of high-throughput. (auth)

28047 (AERE-R-5350) THE RECOVERY OF ^{234}U FROM ^{238}Pu. Wain, A. G. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 17p. Dep. CFSTI. UK 2s. 6d.

^{234}U of high isotopic purity was separated from ^{238}Pu aged for about 2 years. The separation was achieved by three cycles of anion exchange from 8M HCl solution. 8.54 mg of ^{234}U were separated with an isotopic purity of 98.82%, and contaminated by only <0.36 parts of ^{238}Pu per million. The yield of ^{234}U was about 75% of the theoretical. (auth)

28048 (EUR-3451.f) RECUPERATION DU ^{137}Cs DANS LES SOLUTIONS DE PRODUITS DE FISSION PROVENANT DES ALLIAGES URANIUM-MOLYBDENE. (Recovery of ^{137}Cs From Uranium-Molybdenum Alloy Fission Product Solutions). Aubertin, Ch.; Lefevre, J.; Raggenbass, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 2, 1967. 42p. (In French). Dep.

The use of uranium-molybdenum alloys in power reactors influences the concentration of the aqueous extraction phases containing fission products. When added during concentration, phosphoric acid has the effect of combining with the molybdenum to form the more soluble phosphomolybdic acid; this enables the desired concentration factors to be reached. During this phase, the cesium precipitates as cesium phosphomolybdate, and zirconium as a phosphate. However, the cesium can still be recovered from the precipitate by alkaline treatment, which renders the cesium salt soluble and allows zirconium oxide to remain in the precipitate. The cesium phosphomolybdate is reformed by acidification of the alkaline solution, the treatment being continued by the conventional process of separating the cesium-137 by phosphotungstic acid. (auth)

28049 (IN-1088) RECOVERY OF URANIUM FROM EBR-I CORE 2 MELTED FUEL. Jacobson, M. E.; Mascarenas, R. R.; Offutt, G. F.; Rohde, K. L. (Idaho Nuclear Corp., Idaho Falls). May 1967. Contract AT(10-1)-1230. 17p. Dep. CFSTI.

The uranium from Core 2 (the melt-down core) of the Experimental Breeder Reactor I was recently recovered at the Idaho Chemical Processing Plant using specially devised procedures. Information on the dissolution and solvent extraction procedures together with the flowsheets is given. (auth)

28050 (JAERI-1132) STUDIES ON THE SOLVENT EXTRACTION OF ACTINIDE ELEMENTS BY ORGANOPHOSPHORUS COMPOUNDS. Watanabe, Kenju (Japan Atomic Energy Research Inst., Tokyo). Nov. 1966. 95p. Dep.

A radiochemical survey was made on the extraction of actinide elements by TBP, TBPO, and TOPO from hydrochloric and nitric acid solutions. In general, most of the elements studied were more extractable in the extraction systems of phosphine oxides than in those of phosphate. Influence of the variation of acid concentration on the distribution ratio of the elements was more remarkable in the former system than in the latter. The extraction of thorium and uranium chlorides by TBP or TOPO was studied. The composition of complexes extracted from the chloride solution of low acid concentration was established by partition study to be $UO_2Cl_2(TOPO)_2$, $UCl_4(TOPO)_2$, $ThCl_4(TOPO)_2$, and $UCl_4(TBP)_2$. The composition of thorium complex in the TBP phase free from hydrochloric acid was revealed by infrared study to be $ThCl_4(TBP)_4$. A study on the extraction of curium from nitrate solution by TOPO suggested that the composition of the complex extracted was $Cm(NO_3)_3 \cdot (TOPO)_3$. The results obtained in the extraction of individual elements were applied to the separation of specific mixtures. Small amounts of uranium-233 were separated from irradiated thorium by extraction with TBPO. Uranium and plutonium were separated from each other by a continuous fractional extraction method using a couple of small pulse columns. Reversed phase column chromatography was applied to the separation of americium from rare earths after coprecipitation. HDEHP and TOPO-xylene solutions held on kiesulguhr were used as the stationary phase and the elutions were carried out with 0.1 to 1N nitric acid solutions. In the HDEHP system, americium was effectively separated from the rare earths except from praseodymium. Americium could also be separated from europium in the TOPO system. (P.C.H.)

28051 (NP-16723) DETERMINACION DE CONDUCTIVIDAD ELECTRICA EN LIQUIDOS DE UNA PLANTA DE TRATAMIENTO DE MINERALES DE URANIO CON UN PUENTE LIQUIDO BALANCEABLE A CORRIENTE DIRECTA. (Determination of Electric Conductivity of Electrolytic Solutions for Treatment of Uranium Minerals). Perez, Marta Rodriguez (Universidad Nacional Autonoma de Mexico, Mexico City. Escuela Nacional de Ciencias Quimicas). 1965. 59p. (In Spanish). Dep. Thesis.

A direct-current liquid bridge for determination of the conductivity of electrolytic solutions was developed. It is of simple construction and is the electric circuit most sensitive for the determination. Tests made on uranyl nitrate and liquors from the alkaline leaching of uranium minerals showed that it is possible to determine the conductivity of solutions with an exactitude comparable to that obtained with very elaborate alternating-current electric circuits. (J.S.R.)

28052 (NP-16746) EXTRACTION-CONCENTRATION DE CATIONS METALLIQUES EN SOLUTIONS DILUEES A L'AIDE D'AGENTS TENSIO-ACTIFS. ESSAIS D'APPLICATIONS A LA DECONTAMINATION D'EFFLUENTS RADIO-ACTIFS. (Extraction-Concentration of Metallic Cations in Dilute Solutions by Means of Surface-Active Agents. Applications Tests in Decontamination of Radioactive Effluents). Arod, J.; Fould, H.; Wormser, G. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jan. 1964. 89p. (In French). (SC-64-049). Dep.

Studies on the extraction of strontium ions in dilute solution using a foaming agent with the active anion sodium lauryl sulfate are reported. The various parameters that can modify the fixation of strontium ions on the tensio-active agent were studied. (tr-auth)

28053 (NP-16771) DISENO DE UN SISTEMA DE REPULPADORES Y ASENTADORES PARA EL LAVADO DE LOS SOLIDOS PROVENIENTES DE LA LIXIVIACION ALCALINA DE MINERALES URANIFEROS. (Use of a System of Repulpers and Settlers for the Washing of Solids Coming from the Alkaline Leaching of U Ores). Gasca Neri, Rogelio (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Quimica e Industrias Extractivas). 1964. 92p. (In Spanish). Dep. Thesis.

Processes used in the treatment of U minerals are summarized. The theory applicable to the washing and settling of solids of leached pulps is derived. An experimental study is made of the yield from a semi-industrial installation using a system of repulping and settlers. The material balance in such a semi-industrial installation is calculated and an economic study is made. (J.S.R.)

28054 (ORNL-TM-1876) APPLICATION OF HIGH PRESSURE ION EXCHANGE COLUMN TO THE SEPARATION OF TRIVALENT ACTINIDES AND LANTHANIDES. Buxton, S. R.; Campbell, D. O. (Oak Ridge National Lab., Tenn.). May 9, 1967. Contract W-7405-eng-26. 24p. Dep. CFSTI.

A high-pressure ion exchange system has been tested by separating neodymium from praseodymium, a problem representative of those presented by the trivalent actinide separations, by chromatographic elution with α-hydroxyisobutyric acid from Dowex 50 resin. A high-pressure pump is used to force solutions at a high flow rate through a column which contains resin of small particle size. The high pressure permits greater freedom in the selection of operating parameters such as resin particle size, column length, and flow rate. The system has the capability of accomplishing anything that can be accomplished by any conventional ion exchange column system, but with much higher flow rates and, therefore, in much less time. Deleterious effects of radiation damage from high-activity level materials are accordingly minimized. Operation has been unusually smooth, and essentially no problems have arisen. Quantitative separations have been obtained routinely with flow rates up to 25 ml cm^{-2} min^{-1}, much higher than are normally used. The experiments were done on a scale generally of the order of 100 mg of rare earth rather than the more usual tracer level. The degree of separation could be controlled from some overlap of the elution bands to complete separation, by controlling the eluent concentration. Operation at elevated temperature is generally desirable because the pressure drop is lower at a given flow rate, but temperature appears to have only a minor effect on kinetics as indicated by band tailing. Elution bands are not symmetrical, showing a slow, nearly linear increase in concentration followed by an abrupt decrease. (auth)

28055 (ORNL-TM-1880) HOT CELL EVALUATION OF THE GRIND-LEACH PROCESS WITH IRRADIATED PYROLYTIC CARBON-COATED SOL-GEL THORIA-URANIA PARTICLES. Goode, J. H.; Flanary, J. R. (Oak Ridge National Lab., Tenn.). May 26, 1967. Contract W-7405-eng-26. 6p. Dep. CFSTI.

Duplex pyrolytic carbon-coated sol-gel ThO_2 and $(Th,U)O_2$ particles, irradiated from 15,000 to 17,500 MWd/metric ton (Th + U) and decayed 10 and 19 months, were ground to -100 mesh to insure fracture of the coatings and, then, were leached with boiling fluoride-catalyzed nitric acid to dissolve the thorium, uranium, and fission products. Recoveries of 99.6% or more of the uranium and 99.9% of the thorium were realized, along with dissolution of more than 86% of the gamma emitters. These results contrast markedly with earlier grind-leach studies, using

ground graphite-matrix fuel that contained laminar-coated $(Th,U)C_2$ particles, which gave unacceptable losses of up to 6.9% of the thorium and 4.5% of the uranium to the leached carbon residue. Grinding and leaching may therefore be applicable to HTGR fuels containing coated sol-gel oxide particles, although the feasibility of the process would still be marginal due to the necessity of storing the fission product-contaminated residue as a high- or intermediate-level solid waste. (auth)

28056 (SECA-063) EXTRACTION-CONCENTRATION DE CATIONS METALLIQUES A L'AIDE D'AGENTS TENSIO-ACTIFS. (Extraction-Concentration of Metallic Cations by Means of Surface-Active Agents). Arod, J.; Fould, F.; Wormser, G. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Nov. 1964. 60p. (In French). Dep.

The various tests made on foam countercurrent extraction of Sr, Cs, and Ce are reported. The technology of foam columns operating in countercurrent was studied and tensioactive agents having a high affinity for the chemical species precipitated even in media highly charged with sodium salt were investigated. The results obtained showed that foam countercurrent techniques for the extraction of Sr, Cs, and Ce might be suitable for large-scale operations. (J.S.R.)

28057 (SECA-085) EXTRACTION-CONCENTRATION DE CATIONS METALLIQUES EN SOLUTION DILUEE A L'AIDE D'UN AGENT TENSIO-ACTIF CHELATANT. ESSAIS D'APPLICATION A LA DECONTAMINATION DES EFFLUENTS RADIOACTIFS. (Extraction-Concentration of Metallic Cations in Dilute Solutions by Means of Surface-Active Chelating Agents. Applications Tests in Decontamination of Radioactive Effluents). Arod, J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Apr. 1966. 64p. (In French). Dep.

Experiments on the extraction of strontium, cesium, and cerium ions in dilute solutions using the tensio-active chelating agent sodium dodecyl benzyl diethylenetriaminetetraacetate are reported. To study the application of this agent to the decontamination of radiochemical effluents, several pilot operations were developed and exploited. One was a pilot operation of 100 l/hr for the extraction of strontium ions from media charged with sodium nitrate. Another was a 4 l/hr pilot operation that permitted the elimination of Sr, Cs, and Ce ions. This operation included a chemical pretreatment of the effluent, then a percolation of this conditioned effluent on a foam extraction column. Decontamination factors obtained on this arrangement were of the order of 200 for each of the cations with a concentration factor of about 50. (tr-auth)

28058 (SGAE-CH-44/1967) EXTRACTION OF NIOBIUM. Pfeifer, V.; Bildstein, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). Mar. 1967. 12p. (CONF-660805-6). Dep.

From International Conference on Solvent Extraction Chemistry, Gothenburg, Sweden.

A liquid-liquid extraction method is presented for the separation of ^{97}Nb in a carrier-free form from many elements, including Zr and Hf. Nb is extracted into a solution of α-benzoinoxime in chloroform from aqueous hydrochloric acid, which also may contain small amounts of hydrofluoric or oxalic acid. A decontamination factor higher than 10^4 from Zr and other elements is achieved. If necessary, the back-extraction of Nb can be carried out with oxalic acid with or without H_2O_2 and other solutions. (auth)

28059 (ANL-Trans-478) REPROCESSING MIXED OXIDE FUELS BY FLUORINATION. Schmets, J.; Camozzo, G.; Heremans, R.; Pierini, G. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Translated for Argonne National Lab., Ill., from paper presented at the IAEA Symposium on Uses of Plutonium as a Reactor Fuel, Brussels, Belgium, March 13-17, 1967. 24p. (CONF-670306-6). Dep. CFSTI. JCL $2.60 fs, $0.92 mf.

The use of chlorine mono- and trifluorides for reprocessing Zircaloy-clad UO_2-PuO_2 fuels was studied. The multivalent character of the chlorine fluorides, used pure or in a mixture, is discussed. The chief characteristic of ClF_3 is direct attack on the fuel, whereas that of ClF is selective with respect to U. (P.C.H.)

28060 ION-EXCHANGE PROPERTIES OF AMMONIUM SALTS OF HETEROPOLYACIDS. VII. SORPTION OF ^{137}Cs AND ^{86}Rb ON ACID AND NORMAL AMMONIUM AND THALLOUS SALTS OF PHOSPHOTUNGSTIC AND PHOSPHOMOLYBDIC ACID. Krtil, J.; Chavko, M. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). J. Chromatogr., 27: 460-73(Apr. 1967).

The sorption of ^{137}Cs and ^{86}Rb on acid and normal ammonium and thallous phosphomolybdate and phosphotungstate was studied under static conditions. The values of the distribution and selectivity coefficients, which characterize the sorption of ^{137}Cs and ^{86}Rb on these sorbents under different conditions (the presence of ammonium and thallous salts, organo-aqueous medium), were determined together with the values of the separation factors for both elements, and an interpretation of the mechanism of sorption of cesium and rubidium on the sorbents studied was suggested. (auth)

28061 THE EXTRACTION OF LANTHANIDES AND ACTINIDES WITH ALKYLPHOSPHINE OXIDES. PART II. THE EXTRACTION OF NITRIC ACID WITH TRI-n-HEXYLPHOSPHINE, TRICYCLOHEXYLPHOSPHINE AND TRI-n-OCTYLPHOSPHINE OXIDES. Goffart, J.; Duyckaerts, G. (Laboratoire de Chimie Analytique et Nucleaire, Liege). Anal. Chim. Acta, 38: 529-36 (Aug. 1967). (In French).

The distribution of nitric acid between an aqueous phase and a solution of tri-n-hexylphosphine oxide (THPO), tricyclohexylphosphine oxides (TcHPO), and tri-n-octylphosphine oxide (TOPO) in benzene was measured at 25°. The apparent stability constants K_i' were found to be 17.2 ± 1.0 $(M)^{-2}$ for $THPO \cdot HNO_3$, 7.0 ± 0.8 $(M)^{-2}$ for $TcHPO \cdot HNO_3$, and 15.2 ± 1.1 $(M)^{-2}$ for $TOPO \cdot HNO_3$. The stoichiometry of the last complex was confirmed in n-octane solution at constant ionic strength in the aqueous phase. (auth)

28062 NUMERICAL SOLUTIONS OF THE EQUATIONS OF APPROACH TO EQUILIBRIUM IN CLUSIUS-DICKEL COLUMNS FOR TERNARY MIXTURES. Saviron, J. M.; Madariaga, J. A.; Quintanilla, M. (Facultad de Ciencias, Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 109-11(Mar.-Apr. 1967).

An explicit method and the implicit method of Crank-Nicolson's finite differences (Crank, J. and Nicolson, P.; Proc. Camb. Phil. Soc., 43: 50, 1947) were used for solving the nonlineal system of equations for the approach to equilibrium of ternary mixtures in Clusius-Dickel columns. Data on ^{22}Ne and ^{20}Ne were used, and calculations were made by an IBM 1620 computer. Similar results were obtained with both methods, although the implicit method was less time-consuming. (J.G.B.)

28063 SEPARATION OF ^{131}I FROM NATURAL TELLURIUM BY VACUUM EVAPORATION-CONDENSATION METHOD. Karasev, B. V.; Sychev, Yu. N.; Malyutin, S. P. Radiokhimiya, 9: 136-8(1967). (In Russian).

The process of sublimation of natural Te with its subsequent deposition on heated surfaces in a vacuum can be used for the complete purification of natural Te from I and the production of radiochemically pure Te and ^{131}I from neutron-irradiated Te. (J.S.R.)

28064 DIFFUSION PROCESSES IN CLUSIUS-DICKEL COLUMNS. Saviron, J. M.; Madariaga, J. A.; Quintanilla, M. (Facultad de Ciencias, Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 79-82(Mar.-Apr. 1967). (In Spanish).

A direct method for the measurement of K_d coefficient is proposed. The method uses the column separation as the basis for a remixing process by ordinary diffusion from which the magnitude K_d can be obtained. (J.S.R.)

28065 STUDY OF THE THERMAL DIFFUSION OF SOME Xe ISOTOPES. Saviron, J. M.; Gonzalez, D.; Madariaga, J. A.; Quintanilla, M. (Facultad de Ciencias, Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 83-90(Mar.-Apr. 1967). (In Spanish).

The separations obtained in thermal diffusion columns were calculated for various column lengths. The results are graphed. (J.S.R.)

28066 SEPARATION OF ^{36}Ar BY THERMAL DIFFUSION. Casas, J.; Quintanilla, M.; Saviron, J. M.; Madariaga, J. A. (Facultad de Ciencias, Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 91-8(Mar.-Apr. 1967). (In Spanish).

The separation of ^{36}Ar was measured in an installation having seven columns in series and a reservoir of 50 l at one end. The results obtained were compared with the experimental results. Good agreement was found between theory and experimental results. (J.S.R.)

28067 SYNERGIC EFFECT IN URANIUM(VI) EXTRACTION WITH A MIXTURE OF MONO-N-BUTYLPHOSPHORIC ACID (H_2MBP) AND NEUTRAL ALKYLPHOSPHORIC ACID COMPOUNDS (TOPO, TBP) FROM SULFURIC ACID SOLUTIONS. Deptula, Czeslaw (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 12: 273-80(1967).

It has been found that addition of neutral alkylphosphoric acid compounds (tri-n-butyl phosphate, tri-n-octylphosphine oxide) to

mono-n-butylphosphoric acid solution results in the occurrence of a synergic effect in the extraction of uranium(VI) from sulfuric acid solutions. The values of synergy coefficients are proportional to the basicity of the phosphoryl group of the neutral alkylphosphoric acid compound. The mechanism of synergic extraction of uranium(VI) with a mixture of the studied extractants is explained. (auth)

28068 EFFECT OF TEMPERATURE ON THE EFFECTIVENESS OF THE CHROMATOGRAPHIC SEPARATION OF CERTAIN RARE EARTH PAIRS. Brunisholz, G.; Roulet, R. (Univ., Lausanne, Switzerland). Chimia (Aarau), 21: 188(May 15, 1967). (In French).

The ratios of the stability constants of the EDTA and HEDTA complexes of the rare earths were established for several pairs of these elements. At 25° the pair Eu–Gd cannot be satisfactorily separated on ion exchangers by means of EDTA as eluant; the separation is easy at 75°. At room temperature the stability of the HEDTA complex of yttrium was almost the same as that of neodymium but differed markedly from that of samarium; at 70°, the situation was just inverted. Elution at 50° may provide the best conditions for obtaining pure yttrium using HEDTA as an eluant. (auth)

28069 ECONOMICS OF REPROCESSING INSTALLATIONS USING THE AQUEOUS METHOD. Gupta, D. (Kernforschungszentrum, Karlsruhe, Ger. Institut fuer Angewandte Reaktorphysik, Karlsruhe, Ger.). Atomwirtschaft, 12: 139–43(Mar. 1967). (In German).

Typical energy production, general processing, and special processing costs for individual reactor types were compiled and the proportionate cost of the reprocessing was determined. The cost factors of the processing and the enlargement factors for a centrally located processing plant were given. As long as the throughput can be increased by enlargement of the individual plant parts, the capital investments increase by a power law. The relative significance of enlargement factors and accounting for installations with increased throughput are given. (tr-auth)

28070 NEW DEVELOPMENTS IN ION-EXCHANGE MATERIALS, WITH SPECIAL EMPHASIS ON ION EXCHANGERS CONTAINING PHOSPHORUS, ARSENIC OR ANTIMONY IN THE FUNCTIONAL GROUP. Marhol, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). At. Energy Rev., 4: No. 3, 63-156(1966).

The steadily extending application of ion exchangers in both laboratories and plants stimulates their further development. One of the main development trends at present is toward improvement of the physical and chemical stability of ion exchangers and an increase in their selectivity. Recent developments and the present status in the field of synthesis, properties, and utilization of some groups of ion exchangers are reviewed. Ion exchangers that are potentially important for applications in nuclear technology and some general problems of their development are considered. Results from works published during the last five years are included, while the section on phosphorus- and arsenic-based organic ion exchangers presents results from the past fifteen years. (590 References). (auth)

28071 SYNERGIC AND ANTAGONISTIC EFFECTS IN THE PROCESS OF EXTRACTION OF INORGANIC COMPOUNDS WITH A MIXTURE OF AMINES AND ORGANOPHOSPHORIC ACIDS. THE SYSTEM: $UO_2^{+2} + H_2SO_4 + H_2O$–TRI-n-OCTYLAMINE + MONO-2,6,8-TRIMETHYLNONYL-4-PHOSPHORIC ACID + DILUENT. Deptula, Czeslaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 211-23(1967).

Synergic and antagonistic effects were found to occur in the process of uranium (VI) extraction with a mixture of tri-n-octylamine and mono-2,6,8-trimethylnonyl-4-phosphoric acid. The influence of the concentration of uranyl sulfate, sulfuric acid, and ammonium sulfate on extraction of uranium (VI) with a mixture of the above mentioned extractants was studied. The composition of the extracted compounds was determined and constitutional formulas are proposed. The mechanism of occurrence of the synergic and antagonistic effects is explained. (auth)

28072 RAPID SEPARATION OF ^{137m}Ba FROM A COLUMN LOADED WITH ^{137}Cs. Bastian, J.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 216(Dec. 1966). (In German).

The separation of ^{137m}Ba from the long-lived mother nuclide ^{137}Cs in a column filled with titanium hexacyanoferrate was investigated. The column was eluted with HCl. Results of the separation were tabulated for periods after the filling of the column of one day to 155 days. The data showed that initially 5% of the ^{137m}Ba present in the radiochemical equilibrium was eluted, but later only 1% was eluted. The low percentage of the ^{137m}Ba in the eluant was attributed to the fact that the elution was done very rapidly. The use of a fine-grain titanium hexacyanoferrate should improve the yield. (J.S.R.)

28073 ISOLATION OF ^{137}Cs WITH COPPER FERROCYANIDE-ANION EXCHANGE RESIN. Watari, Kazuo; Imai, Kiyoko; Izawa, Masami (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 190-4(Apr. 1967).

The adsorption and desorption of ^{137}Cs on copper ferrocyanide anion exchange resin are presented in detail. The resin can also be used for the concentration of the ^{137}Cs found in sea water. The nuclide was adsorbed effectively on the resin from water, hydrochloric acid below 4M, and on nitric acid below 1M. After adsorption on the resin, ^{137}Cs was eluted easily with either nitric acid (>6M), ammonium water, or silver nitrate solution. Adsorption on the resin was specific for ^{137}Cs, and the action was due entirely to the ferrocyanide moiety of the resin. This method was more efficient than the co-precipitation method with copper ferrocyanide for the concentration of radiocesium from a large volume of sea water. (auth)

28074 RADIOCHEMICAL SEPARATION OF CADMIUM BY LIQUID–LIQUID EXTRACTION. Mirza, M. Y. (Atomic Energy Commission, Risoe, Denmark); Sani, A. R. Int. J. Appl. Radiat. Isotop., 18: 437-9(June 1967).

Methods are described for the extraction of In, Cd, Ag, Pd, Rh, Ru, Zr, Nb, Yt, and Sr from 1 to 10 M HCl solution using triisooctylamine (TIOA), with special reference to devising a radiochemical procedure for the separation of Cd from these other elements. Suitable radioisotopes of the elements were employed in tracer concentrations. Results are tabulated, and extraction curves are illustrated as a function of HCl concentration. From the data it was apparent that from 1M HCl only In, Cd, Ag, Ru, and Rh would be extracted (Ru, however, was previously separated by volatility methods). Back-extraction with water gave 95, 99, 97, and ~15% recovery of In, Cd, Ag, and Pd, leaving Rh in the organic phase. During the separation $In(OH)_3$ was used to carry down traces of Nb, Zr, and Yt, along with In and elements normally soluble in NH_4OH (also used as back-extractant); during this scavenging operation Cd carry-down did not exceed 5%. The time required for the separation was 25 min. The procedure gave good decontamination, and 70 to 75% of the Cd activity was recovered. The procedure may be applied advantageously for the study of short-lived neutron-deficient isotopes of Cd. (UK)

28075 PROCESS FOR SEPARATING PLUTONIUM FROM URANIUM FROM FISSION PRODUCTS. Knighton, James B.; Knoch, Werner; Steunenberg, Robert K. (to U. S. Atomic Energy Commission). U. S. Patent 3,326,673. June 20, 1967.

A pyrochemical process is described for the separation of Pu, U, and refractory and noble metal fission products, one from the other. The U, Pu, and refractory and noble metal fission product values are dissolved in an alloy that is a donor with respect to the Pu and U values, which is in mutual contact with a molten magnesium chloride-containing salt. The Pu and U values are oxidized by the salt and transferred to it. A second alloy in contact with the salt is a U acceptor but a Pu donor with respect to the first alloy and, on mixing, U values transfer from the salt to the second alloy. A third alloy in contact with the salt is a Pu acceptor with respect to the first and second alloys and, on mixing with the salt, Pu values transfer from the salt to the third alloy, to effect separation of U, Pu, and refractory and noble metal fission products, one from another. (AEC)

28076 MATERIAL EXCHANGE COLUMNS. (to Commissariat l'Energie Atomique). British Patent 1,069,770. May 24, 1967. Priority date Dec. 19, 1963, Switzerland).

A material exchange column in which exchange plates or trays are disposed at intervals one above the other for material exchange between two fluids moving in the column countercurrent to one another is provided with means for making possible an increased pressure drop for the lighter phase in the bubble plate over the height of the column. This feature leads to improved material exchange between the contracting phases. (B.L.M.)

28077 METHOD OF SEPARATING UF_6 FROM BROMINE FLUORIDES. Bennett, M. R.; Cathers, G. I. (to U. S. Atomic Energy Commission). U. S. Patent 3,328,132. June 27, 1967.

A method is described for separating UF_6 from bromine fluorides by selective sorption of UF_6 on sodium fluoride at 100° to 175°C. A mixture of gases containing UF_6 and BrF_3 is contacted with fluorine to convert BrF_3, which is partially sorbed on NaF, to BrF_5, which is not sorbed on NaF. (AEC)

EARTH SCIENCES

Geology

28078 (BMwF-FBK-66-46) UNTERSUCHUNGEN UEBER DAS VERHALTEN VON RADIONUKLIDEN IN KANALISATIONEN UND KLAERANLAGEN IM HINBLICK AUF EINE EINLEITUNG RADIOAKTIVER ABWAESSER MIT KURZZEITIG ERHOEHTEN KONZENTRATIONEN. TEIL 2. (Behavior of Radionuclides in Sewer Systems and Purification Plants Subsequent to Discharge of Radioactive Wastes with Concentrations Increased Over Short Periods. Part 2). Aurand, K.; Arndt, J.; Wolter, R. (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-Boden- und Lufthygiene). Dec. 1966. 36p. (In German). Dep.

A method was developed to take water samples in sewers and open channels. Using several samplers mounted at different heights above the sewer bottom and sampling at a constant rate, it is possible to get samples proportional to flow without adaptation to the shape of the channel. A simple device is designed working without external power supply. Hazards to sewer personnel owing to deposition of ^{131}I in sewer films are studied. Those hazards are negligible at specific activities to 0.1 μCi/l. Laboratory investigations on the ^{131}I-content of the air in contact with sewage containing $Na^{131}I$ were carried out. On the average 1% of the ^{131}I-content of the sewage was found in the air. When chlorinating the sewage, up to 60% of the ^{131}I-content was found in the air. The dependence of the distribution of radionuclides on the flow-pattern in purification plants according to DIN 4261 is discussed. (auth)

28079 (PEL-144) APPLICATION OF RADIOISOTOPES AND RADIATION IN HYDROLOGY. A Bibliography. Rossouw, S. F. (comp.) (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Feb. 1967. 17p. Dep.

Twenty four references with abstracts are included. These references update a previous bibliography (PEL-85) on the same subject. (D.E.B.)

28080 CONTAMINATION OF SOILS WITH ^{90}Sr AT THE EXPERIMENTAL INSTITUTE OF LASKOWICE. Barnowski, R.; Bors, J.; Przestalski, S. Zesz. Nauk. Wyzsz. Szk. Roln. Wroclaw., No. 19, 109-16(1965). (In Polish).

Strontium-90 contamination of tested soils was found to be 20 to 160×10^{-12} Ci/kg of soil. Contamination of uncultivated soils was two to three times that of cultivated soils. (J.G.B.)

28081 MEASUREMENT OF THE THORON FLUX LEAVING THE SOIL. Blanc, Daniel; Fontan, Jacques; Guedalia, Daniel (Faculte de Sciences, Toulouse). Compt. Rend., Ser. A and B, 264: 491-3(Feb. 6, 1967). (In French).

A collector mounted on an ionization chamber gives, directly, the value of the release of thoron on a surface of approximately 1 m^2 in a time less than 10 min. The minimum value measurable is 4×10^{-17} Ci cm^{-2} sec^{-1}; the release is generally 100 times greater. (tr-auth)

28082 CONTRIBUTION CONCERNING THE DETERMINATION OF NATURAL GROUNDWATER FLOW VELOCITIES WITH TRACERS. Duerbaum, H.-J. Atomkernenergie, 12: 130-2 (Mar.-Apr. 1967). (In German).

Groundwater flow velocities determined with the aid of tracers by recording the decreasing concentration of the tracer in one borehole or the arrival of the tracer in a second hole are not identical with the natural flow velocities. They are influenced by the very existence of the hole and are always greater than the natural velocities. It has been computed how great this effect is for the two above-mentioned cases. (auth)

28083 ^{13}C-RICH DIAGENETIC CARBONATES IN MIOCENE FORMATIONS OF CALIFORNIA AND OREGON. Murata, K. J. (Geological Survey, Menlo Park, Calif.); Friedman, I. I.; Madsen, B. M. Science, 156: 1484-6(June 16, 1967).

Carbon unusually rich in ^{13}C($\delta^{13}C$ = +5.4 to 19.0 per mil relative to the Peedee belemnite carbonate standard of the University of Chicago) is characteristic of certain diagenetic limestones and dolomites in the Miocene Monterey Shale of California and the Nye Mudstone of Oregon. This heavy carbon may have originated through low-temperature equilibration between CO_3^{2-} and CO_2 in migrating carbonated waters or between CH_4 and CO_2 in natural gas. Light carbon ($\delta^{13}C$ = –5.6 to –18.2 per mil) derived through nonequilibrium oxidation of organic matter also occurs in the carbonate of Monterey Shale in some localities, but at most places it is much less common than heavy carbon. (auth)

28084 A RADIOTRACER STUDY ON FLOW PATH OF SEEPAGE IN THE COFFER DAMS AT SRISAILAM. Iya, V. K.; Krishnamurthy, K.; Aggarwal, K. S.; Rajagopalan, R. (Atomic Energy Establishment, Trombay, India). Int. J. Appl. Radiat. Isotop., 18: 349-57(1967).

Bromine-82 as potassium bromide was used a tracer. Scintillation counters and G-M tubes, attached to long waterproof cables were used for detection of the tracer in boreholes in the structure of the dam and in the water adjacent to the dam. Some of the major points of entry of seepage and the flow path of seepage across the coffer dam were established. The utility of iodine-131 in this type of experiment was also determined. (auth)

28085 DETERMINATION OF THE RADIOACTIVITY OF OPEN WATER RESERVOIRS. Aksel'rod, F. M.; Shvartsman, G. A. Radiokhimiya, 9: 72-6(1967). (In Russian).

Open water reservoirs contain small amounts of natural and synthetic radioactive isotopes (^{40}K, ^{238}U, ^{232}Th, ^{226}Ra, ^{90}Sr, ^{144}Ce, ^{137}Cs, and others). They may be separated and determined only after a preliminary concentration, which involves the processing of large volumes of water. A method is described in which one water sample is used to obtain concentrates of ^{226}Ra, ^{232}Th, ^{90}Sr, ^{144}Ce, and ^{137}Cs isotopes. The method was used to determine radioactive isotope composition of open water reservoirs of the Moldavian SSR. (ATD)

28086 MIGRATION OF ^{90}Sr IN STAGNANT WATERS. Rovinskii, F. Ya. Radiokhimiya, 9: 80-4(1967). (In Russian).

The migration of ^{90}Sr in lake waters was studied by determining the content of ^{90}Sr, stable Sr^{2+}, Na^+, K^+, Mg^{2+}, and Ca^{2+} ions both in waters of 13 lakes and in the lake bed grounds. The migration of ^{90}Sr in stagnant waters is attributed to the ion-exchange reaction between the water and the lake bed ground. The redistribution of ^{90}Sr in the lakes proceeds mainly by ion-exchange reactions with Ca^{2+}. Equations for prediction the level of contamination of lake waters by ^{90}Sr were derived. Comparable results were also obtained under laboratory conditions using synthetic lake water samples. (ATD)

28087 RADIOACTIVITY OF THE BLACK SLATES OF THE PERMIAN TOYOMA SERIES IN MIYAGI PREFECTURE, NORTHEAST HONSHU, JAPAN. Kondo, Tsutomu (Hokkaido Univ., Japan). Chishitsugaku Zasshi, 72: 427-37(Sept. 1966). (In Japanese).

Measurement of radioactivity (mainly gamma activity) was carried out for black slates of the Permian and Triassic deposits, especially the Toyoma black slates around Motoyoshi-cho in the Kitakami Mountains. Thorium and uranium contents in the Toyoma black slates were also analyzed. The results are as follows: (1) Black slates of the Toyoma series, Uppermost Permian in age, are apparently similar in lithologic nature throughout the Kitakami Mountains. However, the contents of trace elements and the intensity of radioactivity vary with the geographic position and with the stratigraphic horizon. (2) Within the Toyoma series, the higher the stratigraphical horizon the stronger the radioactivity. (3) As to the horizontal distribution of radioactivity, the area of high intensity seems to correspond to the possible transitional zone between the shallow shelf (oxygenation zone) and the deeper central part (reduction zone) of the ancient sea in which the Toyoma series was deposited. (4) Contents of thorium and uranium in two samples of the Toyoma black slates are as follows: (a) Th, 13 ppm; U, 10 ppm, (b) Th, <10 ppm; U, 11 ppm. The uranium content is by far higher than in the shales or slates of other stratigraphical horizons in Japan, the amount being nearly three times as large as that in the latter. (NSA of Japan)

28088 γ BACKSCATTERING METHOD FOR THE ORE CONCENTRATION DETERMINATION IN MINING. Donhoffer, D. (Reaktorzentrum, Seibersdorf, Austria). Atomwirtschaft, 12: 127-30(Mar. 1967). (In German).

The applicability of the γ backscattering method for determination of the ore content in bore holes made for determination of ore occurrence was investigated in a Zn–Pb mine. With the help of calculated calibration curves, the measurements were evaluated and compared with chemical drill analyses. The results show that in the region up to 6%, Zn can be calculated with an accuracy of ±1% Zn. In major occurrences of an ore the method is recommended as very rapid and sufficiently accurate. (tr-auth)

28089 RADIOGENIC ORIGIN OF ARGON IN THE COMPOSITION OF NATURAL AND PETROLEUM GAS. Kushko, L. M.; Zverev, I. D. Petrol. Geol. (USSR) (Engl. Transl.), 6: No. 9, 560-2(Dec. 1966).

In a study of Ar in the Zhukov oil field, the variation found in the percentage content of radiogenic Ar on a background of its total increase in amount with depth was explained by differing gas sat-

uration of the oils. Analysis of the isotopic composition of Ar samples revealed the presence of Ar of atmospheric and radiogenic origin: in samples of natural gas all the Ar was of atmospheric origin, whereas in samples of casing head gas, atmospheric and radiogenic Ar was found. There was an overall systematic increase in the content of radiogenic Ar with depth (i.e., the older the rocks that contained the oil, the greater the content of radiogenic Ar). The large value of the ratio of the content of radiogenic Ar to the total amount of Ar raises the question as to the introduction of appropriate corrections for radiogenic Ar in geochemical formulas in which the Ar content is a parameter. (BBB)

28090 ABUNDANCE RATIOS BETWEEN THE AVERAGE BASIC ROCK AND CHONDRITES AS A FUNCTION OF RECIPROCAL IONIC RADII. Masuda, Akimasa (Tokyo Univ.). Tectonophysics, 2: 299-317(1965).

The correlation between ionic radius of lanthanide elements, U, Th, and other elements and their abundance in chondrites was examined. There appeared to exist a linear relation between the reciprocal ionic radius and the partition coefficient of element for the fractional crystallization of silicate melt. This was reflected by the fact that the abundance ratios of elements in liquid-type terrestrial materials to those in chondrites change in log-linear manner with the reciprocal ionic radii. The linear relation was applied to account for a factor in the empirical formula for the abundance relations among U, Th, and Pb, obtained from the isotopic composition of common lead of ores. The percentage of oxidized iron in the initial chondrite-like material for the earth was estimated to average 13.5%. This implies that the percentage of unoxidized iron that could produce Ni–Fe alloy is 13.2% of the initial primitive material. Consequently, the earth's core may consist of ~1:1 mixtures of Ni–Fe alloy and chondrite-like material. If the relation between the partition coefficient and the reciprocal ionic radius is also assumed to hold for Zn, its initial abundance is estimated to be 454 atoms per 10^6 Si atoms, in good agreement with the Suess-Urey abundance. (BBB)

28091 EFFECT OF MOISTURE TENSION OF THE CONCENTRATION OF TRACER ^{85}Sr IN EXPRESSED SOIL SOLUTION. Nishita, H.; Hawthorne, H. A. (Univ. of California, Los Angeles). Soil Sci., 103: 339-46(May 1967).

The concentration of tracer ^{85}Sr in soil solutions extracted with pressure membrane extractors was examined in relation to variable moisture content in different kinds of soils. The ^{85}Sr radioactivity in the soil solution was expressed as solubility factor, which was defined as the ratio of the amount of ^{85}Sr per ml of soil solution to the amount of ^{85}Sr per g of soil before extraction. For any given soil, the ^{85}Sr solubility factors increased as the soil-moisture tension increased. With soils of low moisture level, the solution extracting system did not attain the apparent equilibrium state by the end of the extraction period. For the majority of the soils studied, the critical moisture level for the attainment of apparent equilibrium state was between 0.1 bar and 1 bar. The ^{85}Sr solubility factors varied over a wide range among the different kinds of soils. For the 0.1-bar moisture range, the solubility factors for extracts at the apparent equilibrium state varied from about 0.009 to about 0.74. Various factors that appeared to affect the magnitudes of solubility factors are discussed. (auth)

28092 ZODIACAL DUST AND DEEP-SEA SEDIMENTS. Singer, S. Fred (Univ. of Miami, Coral Gables, Fla.). Science, 156: 1080-3(May 26, 1967).

The recent detection of radioactive ^{26}Al in marine sediments led to the conclusion that it is brought into the earth's atmosphere by micrometeorites exposed, in interplanetary space, to solar high-energy protons. The ^{26}Al method is not precise enough to yield directly a reliable value for the mass accretion rate to the earth to better than about 3 orders of magnitude, but it is sufficiently accurate to allow a decision between two widely differing models of interplanetary dust, which were proposed to explain observations of the zodiacal light. The two models lead to ^{26}Al concentrations that would differ by about 5 orders of magnitude. Thus, the presence of ^{26}Al is consistent only with the zodiacal dust model with particles of some tens of microns rather than with submicron particles. From this model a mass accretion to the earth can then be calculated. It is set at 1250 (upper limit, 2500; lower limit, 250) tons per day, or 2.8×10^{-15} g/cm^2 sec, or 4.5×10^{11} g over the earth per year. This value does not depend on the flux of the solar high-energy particles, which may be uncertain by an order of magnitude or more. The presence of ^{26}Al supports the idea that an important fraction of the dust is stony in composition and material density, and thus eliminates some more exotic dust models, such as one consisting entirely of carbon grains. It may be concluded that the accreted dust particles have been in the solar system and exposed to protons from solar high-energy particles for a time interval greater than a significant fraction of the ^{26}Al half-life (0.74×10^6 years). (auth)

28093 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V GIDRAVLICHESKIKH I GIDROLOGICHESKIKH ISSLEDOVANIYAKH. (Uses of Radioactive Isotopes in Hydraulic and Hydrological Studies). Vartazarov, S. Ya. Moscow, Atomizdat, 1967. 185p.

Tracer studies connected with the hydraulics of natural and artificial water basins and reservoirs are systematized. Radioactive tracers have been used for resolving some problems on the transfer and disposal of radioactive waste, the dynamics of radioactive waste flow and distribution in rivers and water basins, the characteristics and structure of turbulent water flow and for calculating diffusion in streams. Tracers have also been used in studies of closed conduct hydraulics such as in hydroelectric power plants and in bed-load and suspended sludge flow analyses of rivers and basins. (R.V.J.)

28094 POLEVYE YADERNYE GEOFIZICHESKIE METODY. (Field Methods of Nuclear Geophysics). Baranov, V. I. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 224p.

New developments at the Laboratory of Nuclear Geophysics are examined. Descriptions are given of portable γ spectrometers, methods for rock density determination by γ attenuation, portable γ densitometers, methods for the determination of the ash content of coals and their original outcrop by reflected β irradiation, nuclear methods for the determination of boron and boron magnetite deposits, and new methods for the determination of the moisture content of rocks under field conditions. (tr-auth)

28095 METHOD OF AND APPARATUS FOR LOGGING BOREHOLES. Threadgold, Philip; Thomas, Godfrey Stuart (to British Petroleum Co. Ltd.). British Patent 1,071,415. June 7, 1967. Filed Jan. 10, 1963.

A well logging device for several simultaneous measurements aimed at estimation of quantities of oil and gas, for example, available in strata is described. The probe combines resistivity measurements and acoustic analysis with neutron–gamma measurements and used time multiplexing in pulse handling. (R.E.U.)

28096 METHOD OF AND APPARATUS FOR LOGGING BOREHOLES. Threadgold, Philip; Claytor, Howard Francis (to British Petroleum Co. Ltd.). British Patent 1,071,416. June 7, 1967. Filed Jan. 10, 1963.

Refer to abstract for the co-pending British Patent now numbered 1,071,415. (R.E.U.)

28097 METHOD OF AND APPARATUS FOR LOGGING BOREHOLES. Ward, Eric Henry (to British Petroleum Co., Ltd.). British Patent 1,071,413. June 7, 1967. Filed Jan. 10, 1963.

A radiometric well logging device is described that overcomes the pulse-degradation problems introduced by long logging cables by multiplexing (in time) of position-modulated electrical pulses from detectors of neutron-activation photons. Means are provided for recording the spectral information. (R.E.U.)

Meteorology

Refer also to abstract 28131.

28098 (GA-7598) CALCULATIONAL MODEL FOR CONDENSED STATE DIFFUSION CONTROLLED FISSION PRODUCT ABSORPTION DURING FALLOUT FORMATION. Korts, Richard F.; Norman, John H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 10, 1967. Contract N0022866C0403. 91p. CFSTI.

A program is presented to compute fallout fission product absorption in an expanding, cooling, uniform field of gas and fallout particles where the rate of fission product absorption is controlled by fission product surface concentrations as given by Henry's law constants and diffusion of these fission products into the fallout particles. Calculations are made for a nuclide chain at a time, employing nuclear device and fission product parameters. Program output includes average concentration versus particle size for each absorbed fission product at a preselected lower temperature and the amount of that fission product in the gas phase, with an option for the calculation of fission product radial profiles versus particle size. As a demonstration of this model, an initial computer study of fallout formation phenomenology is presented. (auth)

28099 (LA-DC-8524) CHARACTERISTICS OF THE RADIOACTIVE POLLUTANT FROM GROUND TESTING OF NUCLEAR PROPULSION REACTORS. Henderson, Richard W. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 11p. (CONF-670704-3). Dep. CFSTI.

From IAEA Symposium on Instruments and Techniques for the Assessment of Airborne Radioactivity in Nuclear Operations, Vienna, Austria.

The radioactive pollutant resulting from the ground testing of nuclear propulsion reactors is initially released as a distributed vertical line source. The resultant ground level contamination pattern is much like what would be expected from a two point release; one at ground level and a second at about 2000 m above ground. The material in the cloud is composed of volatile fission products or the daughters of volatile fission products. The major contributors to the activity are in three mass groups, 89 to 93, 129 to 135, and 140 to 144. The Sr and Y have been measured on the ground and aloft, and tin and Sb have been measured in the cloud aloft as well. In the third group, Ba and La have been measured on the ground and aloft, and Ce has been measured in the aircraft samples. It appears that the discontinuity between the last two groups is due to Xe remaining in the reactor. The pollutant, at distance, behaves as two clouds, one made up of gaseous material and the second of particulate. The activities of the two remain in a nearly constant ratio out to 25 miles along the hot line. It appears that the gaseous cloud suffers more lateral diffusion than the particulate fraction. The particulate fraction appears to be composed of particles principally in the submicron range. Depletion of the cloud seems to be largely by turbulent impaction or sorption. Correlation between airborne levels and ground concentrations is poor. Deposition velocities which have been measured are statistical in nature and show a log normal distribution with a mean of 0.5 cm/sec and a geometric standard deviation of about 10. The concept of a constant deposition velocity is most probably not valid. Direct measurements of the ground level dose due to cloud passage and ground deposition tend to confirm the presence of the precursors to the isotopes measured but as yet yield no quantitative data in this regard. (auth)

28100 GEOCHEMICAL BEHAVIOR OF FRESH NUCLEAR DEBRIS OF KNOWN ORIGIN IN THE ATMOSPHERE. Sotobayashi, Takeshi; Koyama, Seitaro; Suzuki, Toshio (Niigata Univ., Japan). Bull. Chem. Soc. Jap., 40: 1269-70(May 1967).

The geochemical behavior of fresh nuclear debris from a Chinese atomic bomb explosion at ground level on October 16, 1965, and the venting of a large-scale Russian underground nuclear test on January 15, 1965, is discussed. A relatively short-lived isotope ^{89}Sr (half-life 50.4 days) served as a tracer. The concentration of nuclear debris in air was obtained by measuring the activity in precipitation occurring during the period from October to March. The mean specific activity of ^{89}Sr in rain decreased at a more rapid rate than the radioactive decay rate of ^{89}Sr during the period from late October to December 1964; however, the specific activity of old ^{90}Sr was almost unchanged. The mean residence time obtained from specific activity and isotope ratio were comparable. An average value of 27 ± 6 days was estimated for the Chinese ^{89}Sr. The Russian debris showed a shorter apparent residence time of 4 days. (D.H.M.)

28101 DISCUSSION OF THE PAPER BY J. N. BECK AND P. K. KURODA, "RADIOSTRONTIUM FALLOUT FROM THE NUCLEAR EXPLOSION OF OCTOBER 16, 1964." Feely, H. W. (Isotopes, Inc., Westwood, N. J.). J. Geophys. Res., 72: 3295-9(June 15, 1967).

Beck and Kuroda (J. Geophys. Res., 71: 2451-6) used variations in the $^{89}Sr/^{90}Sr$ ratio in precipitation at Fayetteville, Ark., to deduce that the first Chinese explosion injected 14.5 kCi of ^{90}Sr into the stratosphere and 4 kCi into the troposphere, equivalent to a yield of 170 kt. The assumptions and weaknesses in their calculations are criticized, and it is concluded that, even if injection into the stratosphere occurred, the fission injection can be calculated as 2.2 kCi, equivalent to a yield of 20 kt or less. (D.L.C.)

28102 ^{90}Sr CONCENTRATIONS AND STRATOSPHERIC TRANSPORT. Krey, P. W. (Atomic Energy Commission, New York). J. Geophys. Res., 72: 2987-96(June 15, 1967).

Stratospheric seasonal trends in ^{90}Sr concentrations at 24 to 36 km from January 1963 show a spring minimum and summer-to-fall maximum in the midlatitudes of each hemisphere. Whereas there is evidence of horizontal transport from other latitudes, one possible explanation for these trends is a subsidence in the winter and a lifting in the summer of stratospheric air with a mean vertical velocity of about 0.05 cm/sec. The behavior of ^{102}Rh, ^{109}Cd, and SNAP-9A ^{238}Pu concentrations qualitatively support the existence of this type of stratospheric transport. Based on the observed seasonal trends, estimates of future ^{90}Sr concentrations in the stratosphere indicate the need for larger sampling volumes to permit adequate precision of analysis. (auth)

28103 ^{90}Sr DEPOSITION IN NEW YORK CITY. Volchok, H. L. (Atomic Energy Commission, New York). Science, 156: 1487-9(June 16, 1967).

Measurements of strontium-90 deposited in New York City over the past 12 years make for broader understanding of the fallout phenomenon. The data indicate a stratospheric half-residence time of 8 to 10 months. The seasonal oscillation of strontium-90 fallout is very symmetrical and consistent from year to year and completely independent of the timing and magnitude of nuclear tests. The predicted fallout of strontium-90 in 1970 is less than 1 percent of that during the peak year 1963. (auth)

28104 RATIOS OF RADIONUCLIDES OF STRONTIUM IN FALLOUT AFTER THE THIRD NUCLEAR TEST IN CHINA. Santholzer, Vilem; Stransky, Pravoslav; Knaifl, Josef (Charles Univ., Hradec Kralove, Czechoslovakia). Jad. Energ., 13: 184-5(May 1967). (In Czech).

Fresh fission products were demonstrated by radiochemical separation of strontium from atmospheric fallout. The ratio of $^{89}Sr/^{90}Sr$ activities was 2.44 70 days after the nuclear test. The theoretically expected value of this ratio is 24 to 36 according to the type of fission. Kuroda et al. found the value of this ratio to be about 1 two months after the second Chinese test, which agrees with our result. The great difference from the theoretical value is due to fractionation phenomena, meteorological influence, and rotation of the radioactive cloud around the earth. Fresh fallout was also proved by measurements of the absorption of beta rays of the separated mixture of $^{89}Sr + ^{90}Sr$. In fresh fallout the ^{89}Sr predominates and the half-value layer was about 110 mg/cm^{-2}, while for ^{90}Sr it is 170 mg/cm^{-2}. (auth)

28105 EVALUATING METHOD FOR GROUND SURFACE CONTAMINATION DURING RAIN. Kakuta, Michio (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 9: 186-91(Apr. 1967). (In Japanese).

The frequency of the occurrence of rain is compared with that of other "adverse" meteorological conditions assumed in some reactor hazard reports. An equation for surface contamination distribution during rain is presented, which takes account of deposition as well as rain scavenging. Discussion is made on the value of direct deposition velocity and on the validity of simplified techniques for the safety evaluations. (auth)

28106 RELATIONS BETWEEN THE VARIATIONS OF NATURAL RADIOACTIVITY OF THE AIR AND OF ATMOSPHERIC CONDITIONS ABOVE THE ATLANTIC OCEAN. Fontan, Jacques; Blanc, Daniel; Bouville, Andre; Lacaze, J. (Univ., Toulouse). J. Mec. Phys. Atmos., 5: 113-30(Oct.-Dec. 1963).

Determinations of atmospheric radioactivity were made in June 1962, over the Atlantic Ocean at Point K (45°N latitude, 16°W longitude) from the meteorologic research vessel "France II". It was shown that radioactive equilibrium is reached, over the ocean, between Rn and its descendents. Temporal variations in the concentration of Rn in air over the ocean could be correlated with meteorologic factors. Thus weak atmospheric radioactivity was associated with west winds and higher activity with east or northeast winds. Thus when the air masses at Point K originated from France or Great Britain, the Rn level varied from 10 to 20 pCi/m^3. When air masses came from northern Spain, the level rose as high as 40 pCi/m^3. With west winds the activity fell to 2 pCi/m^2. Detailed meteorologic correlations of Rn measurements are shown in terms of relative humidity, barometric pressure, wind speed and direction, and temperature. The results indicate that measurements of atmospheric radioactivity over the ocean may provide supplementary meteorologic data for following the movement of air masses. (BBB)

Mineralogy

28107 (EUR-3461.e) NOTE ON THE DISTRIBUTION AND PREDICTABILITY OF MINERAL RESOURCES. Brinck, J. W. (European Atomic Energy Community, Brussels (Belgium). Supply Agency). May 1967. 26p. Dep.

An estimate is presented of the order of magnitude of the mineral resources of an element as a function of its natural abundance and distribution in the accessible parts of its terrestrial environment, irrespective of present-day considerations with regard to market conditions and treatment technology. The normal geostatistical methods of mineral exploration and geochemistry are used to link the estimated grade and size distribution of the known ore reserves of uranium, copper, zinc and lead with the average abundance of these elements in the upper part of the lithosphere. The "reference distributions" thus found can be employed for calculating the order of magnitude of the probable mineral resources related to the known ore reserves. Corroborating evidence to justify such extrapolations on the basis of the, mostly roughly estimated, parameters of the ore reserves is sought in the results of a geochemical survey on recent stream sediments in the Oslo region, Norway, for the elements copper, zinc and lead. Allowances were made for the special metallogenetic characteristics of the Oslo

region, comparison of the respective reference distributions with the survey distributions indicate that the model of log-normal distribution of element concentrations in the lithosphere can be used advantageously for the, at least semi-quantitative, estimation of the mineral resources of these elements, both from their known ore reserves and, under certain favorable conditions, from regional geochemical surveys. In the second case, such surveys seem to permit a quick and inexpensive appraisal of the metallogenetic characteristics of the region surveyed and its prospects for the occurrence of ore-grade mineralization in comparison with the upper lithosphere as a whole. (auth)

28108 PETROGRAPHIC OBSERVATIONS OF BOGHEAD SHALES LEADING TO URANIUM AND THORIUM FROM AUTUN (SAONE-ET-LOIRE) WITH SPECIAL CONSIDERATION OF RESULTS OF FLUORESCENCE MICROSCOPY. Wolf, Monika (Geologisches Landesamt Nordrhein-Westfalen, Krefeld, Ger.). Brennstoff-Chem., 48: 11-14(1967). (In German).

Samples of Boghead schist from the basin of Autun were examined in sections. The chief component is algae, Pila bibractensis, buried in a clay in which fusinite, calcite crystals, albite, quartz, and pyrite are found. The algal bodies have a maximum diameter of 200 μ. Bright regions are associated with radioactive regions; no reduction in size of the bodies was observed in the vicinity of these spots. Binding of U to organic matter as well as clay was observed. Fluorescence data are adduced to indicate the nature of the changes affected in the organic material through α radiation; the algal substance is not fluorescent in the region of radioactive influence, although it fluoresces yellow otherwise. This might suggest reduction of conjugated systems as a result of radiation. (BBB)

28109 PALYNOLOGICAL CHARACTER OF URANIFEROUS COAL. Tokunaga, Shigemoto. Nenryo Kyokai-Shi, 45: 839-42 (Dec. 1966). (In Japanese).

A palynological survey of the uraniferous coal deposits of the Ouchi area, Miyagi Prefecture was done systematically. These deposits are in an area where tertiary strata are distributed over granite mass. The Miocene-type pollen and spores together with fossil impressions found in the strata are thought to indicate a warm temperate paleoclimate during coal seam formation. (TSS)

28110 RADON EMANATION FROM URANIUM ORES AND MINERALS IN LIQUID FORM. Prutkina, M. I.; Shashkin, V. L. At. Energ. (USSR), 22: 140-1(Feb. 1967). (In Russian).

The radon emanation in water, alcohol, and kerosene from pulverized samples of uranium ores and minerals was investigated. For all the samples, the emanation coefficient was higher in water than in air and in alcohol and kerosene it was almost equal and had an intermediate value between that of air and water. Increase of the moisture by 5% or more led to an increase of the emanation coefficient in air to values almost equal to that in water. (J.S.R.)

Oceanography

28111 (RLO-1725-32) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, JANUARY-JUNE 1963. Volume I. BROWN BEAR Cruise 318: February 27-March 20. ACONA Cruise 6301-E: January 24-25. Technical Report No. 134. Love, C. M. (Washington Univ., Seattle. Dept. of Oceanography). Mar. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 248p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during Cruise 318 of the Research Vessel Brown Bear and biological data collected during Cruise 6301-E of the Research Vessel Acona during the months of January to March 1963 in an area within 250 miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the features of the movement and dispersion of Columbia River effluent water in the northeast Pacific. (auth)

28112 (RLO-1725-33) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, JANUARY-JUNE 1963. Volume II. CNAV OSHAWA Cruise OSHAWA-1: March 12-26. BROWN BEAR Cruise 320: March 28-April 10. Technical Report No. 134. Love, C. M. (Washington Univ., Seattle. Dept. of Oceanography). Mar. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 228p. Dep. CFSTI.

Data are presented on weather and sea conditions of the northeast Pacific Ocean. These data were obtained from Cruise Oshawa-1, March 12 to 26, 1963, and Brown Bear Cruise 320, March 28 to April 10, 1963. A discussion of the objectives of these cruises and the scientific program of which they were a part are found in Volume I, together with descriptions of the observations made, the methods of collecting samples and the methods of determination of properties. A list of the personnel engaged in collecting and preparing the data and a bibliography are also found in Volume I. The cruise tracks and station locations for cruises Oshawa-1 and Brown Bear 320 are presented. (auth)

28113 (RLO-1725-34) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, JANUARY-JUNE 1963. Volume III. BROWN BEAR Cruise 322: April 16-May 1. BETTY A Cruise 1: May 9-11. BROWN BEAR Cruise 323: May 13-19. Technical Report No. 134. Love, C. M. (Washington Univ., Seattle. Dept. of Oceanography). Mar. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 287p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during cruises 322 and 323 of the Research Vessel Brown Bear and biological data collected during Cruise 1 of the chartered fishing vessel Betty A during the months of April and May 1963 in an area within 255 miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the features of the movement and dispersion of Columbia River effluent water in the northeast Pacific. (auth)

28114 (RLO-1725-35) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, JANUARY-JUNE 1963. Volume IV. BROWN BEAR Cruise 324: May 21-June 4. Technical Report No. 134. Love, C. M. (Washington Univ., Seattle. Dept. of Oceanography). Mar. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 184p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during Cruise 324 of the Research Vessel Brown Bear during the months of May to June 1963 in an area within 170 miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the features of the movement and dispersion of Columbia River effluent water in the northeast Pacific. (auth)

28115 (RLO-1725-36) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, JANUARY-JUNE 1963. Volume V. CNAV OSHAWA Cruise OSHAWA-2: May 22-June 12. BROWN BEAR Cruise 327: June 24-July 1. Technical Report No. 134. Love, C. M. (Washington Univ., Seattle. Dept. of Oceanography). Mar. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 240p. Dep. CFSTI.

Data are presented on weather and sea conditions of the northeast Pacific Ocean. These data were obtained from Cruise Oshawa-2, May 22 to June 12, 1963, and Brown Bear Cruise 327, June 24 to July 1, 1963. A discussion of the objectives of these cruises and the scientific program of which they were a part are found in Volume I, together with descriptions of the observations made, the methods of collecting samples and the methods of determination of properties. A list of the personnel engaged in collecting and preparing the data and a bibliography are also found in Volume I. The cruise tracks and station locations for cruises Oshawa-2 and Brown Bear 327 are presented. The values of phosphate, silicate, and nitrate reported for Cruise Oshawa-2 were obtained from samples which were frozen aboard ship immediately after collection and returned to Seattle for later analysis ashore. Phosphate data reported for Cruise 327 were obtained from shipboard analysis of unfrozen samples. (auth)

28116 (RLO-1725-37) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, JANUARY-JUNE 1963. Volume VI. BROWN BEAR Cruise 326: June 13-23. CNAV OSHAWA Cruise OSHAWA-3: June 17-30. Technical Report No. 134. Love, C. M. (Washington Univ., Seattle. Dept. of Oceanography). Mar. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 235p. Dep. CFSTI.

Data are presented on weather and sea conditions of the northeast Pacific Ocean. These data were obtained from Brown Bear Cruise 326, June 13 to 23, 1963, and Cruise Oshawa-3, June 17 to 30, 1963. A discussion of the objectives of these cruises and the scientific program of which they were a part are found in Volume I, together with descriptions of the observations made, the methods of collecting samples and the methods of determination of properties. A list of the personnel engaged in collecting and preparing the data and a bibliography are also found in Volume I. The cruise tracks and station locations for cruises Brown Bear 326 and Oshawa-3 are presented. The values of phosphate, silicate, and nitrate reported for Cruise Oshawa-3 and of silicate and nitrate reported for Cruise 326 were obtained from samples which were frozen aboard ship immediately after collection and returned to Seattle for later analysis ashore. Phosphate values re-

ported for Cruise 326 were obtained partly from frozen samples and partly from shipboard analysis of unfrozen samples. (auth)

28117 (RLO-1725-62) THE COLUMBIA RIVER EFFLUENT AND ITS DISTRIBUTION AT SEA, 1961-1963. Technical Report No. 156. Duxbury, Alyn C.; Morse, Betty-Ann; McGary, Noel (Washington Univ., Seattle. Dept. of Oceanography). June 1966. Contracts AT(45-1)-1385; AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 119p. Dep. CFSTI.

Surveys off the Washington-Oregon coast by the Department of Oceanography, University of Washington, from 1961 through 1963 have provided salinity data for describing the Columbia River effluent in the northeast Pacific Ocean. The data also have provided insight into the interactions between the observed distribution and the meteorological systems. Each salinity distribution is categorized into one of four distinct seasonal patterns, mainly influenced by river discharge and winds. The salinity distributions delineate the extent of the influence of the Columbia River effluent in the northeast Pacific Ocean both horizontally with distance and vertically with depth. Also shown and discussed are the mean wind patterns for the area during this time period, their influence on the river outflow and their role in the transport of the dilute surface waters. A method is described for the prediction of the salinity distribution of the effluent from surface wind data. (auth)

28118 PREDICTION OF POLLUTION FROM PLANNED WASTEWATER OUTFALLS. Harremoes, Poul (Danish Isotope Center, Copenhagen). J. Water Pollut. Contr. Federation, 38: 1323-33(Aug. 1966).

Theoretical and practical aspects of tracing radioisotopes in domestic sewage and industrial effluents are considered. Use of a specially equipped boat for assaying radioactivity in large bodies of water is described. With the equipment used a concentration as low as 0.025 $\mu Ci/m^3$ could be detected. One Ci of ammonium bromide-^{82}Br was used for these investigations. This amount of radioactive material could be detected when equally dispersed in 40×10^6 m^3 of water. Since ^{82}Br has a quick turnover time in animals and human beings, its half-life is only 36 hr, and the radioactivity is dispersed quickly in the water at places considered suitable for receiving effluents, it is completely safe for use as a tracer. The difference in dispersion between continuous injection and a single injection of radioactivity is shown. After sufficient dilution of the radioactivity has taken place, the boat is navigated through the area of radioactivity. A pocket is built into the boat's hull, which is made of fiberglass-reinforced plastic, that contains the γ detector to measure the radiation in the water. In this way the radioactivity is traced in wider circles until it cannot be distinguished from the background. Many sets of isoactivity curves were obtained, each corresponding to a certain time after injection. Statistical treatment of the data is outlined. (BBB)

Seismology

28119 (UCRL-50232) THEORETICAL AMPLITUDES AND TRAVEL TIMES OF EXPLOSION-GENERATED SEISMIC P WAVES. Roberts, John (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 5, 1967. Contract W-7405-eng-48. 10p. Dep. CFSTI.

Amplitudes and travel times have been calculated for the first half-cycle of seismic P waves generated by nuclear explosions at distances varying from 140 to 2900 km. The head-wave-body-wave model constructed yields travel times within ±3.9 sec of the mean experimental values over the indicated range of distances and also provides an interpretation of the large-small-large nature of the amplitudes. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 27897 and 28119.

28120 (AFSCM–500–8) SYSTEMS APPLICATIONS OF NUCLEAR TECHNOLOGY: EFFECTS OF AIR BLAST, GROUND SHOCK, AND CRATERING ON HARDENED STRUCTURES. (Air Force Systems Command, Andrews AFB, Md.). Mar. 1, 1967. 162p.

A qualitative description of air blast and ground shock, and methods for approximating crater dimensions and depths of ejecta produced by nuclear detonations are given. Air blast effects on aboveground structures and air-induced and direct-induced ground shock effects on below-ground structures are considered. Guidelines are given for applying environmental parameters to the evaluation of particular structures. The methods for determining the vulnerability of hardened permanent-type structures to the effects of these weapons are demonstrated. (F.S.)

28121 (SC-RR–66-480) CRATER, EJECTA, AND AIR-BLAST STUDIES FROM FIVE HIGH-EXPLOSIVE CHARGES IN A HORIZONTAL SQUARE ARRAY. Rappleyea, C. Annette (Sandia Corp., Albuquerque, N. Mex.). Apr. 1967. Contract AT(29-1)-789. 158p. Dep. CFSTI.

Fifteen shots, each consisting of five 64-pound spherical charges of cast TNT buried at depths of 6, 8, or 10 feet, were detonated in dry-lake playa at the Tonopah Test Range. Charges were arranged in a horizontal square array with the fifth charge in the middle and with spacings on the side of the square ranging from 8 to 18 feet. One shot using five 8-pound charges and one using five 256-pound charges were fired at the same cube-root scaled burial depths and spacings as one of the shots using a 64-pound charge. Crater dimensions, air blast, ejecta areal distribution, and permanent displacement of the ground surface were measured. The apparent crater volume for the five 64-pound charges was about three times that from a single 320-pound charge detonated at the same depth. The apparent crater radius from five 64-pound charges was 1.5 times that from a single 320-pound charge. Peak overpressures were as much as 1/10 those for a single 320-pound charge at the same burial depth. A distinctive ejecta pattern showed four mounds formed along the flat sides of the square containing amounts of ejecta that varied with depth of burst. Permanent ground motion was irregular but showed a net inward radial motion in many cases. (auth)

28122 (SC-RR–67-24) STUDY OF THE MECHANICS OF SLIDE DAMS WITH SAND MODELS. Young, George A. (Michigan Technological Univ., Houghton. Dept. of Civil Engineering). Apr. 1967. Contract AT(29-1)-789. 107p. Dep. CFSTI.

Results of experimental laboratory work performed to study the effects of valley and slide geometry on model dam profiles are presented. Some consideration was also given to the physical properties of the slide materials. Two idealized experimental models were used. The first, a plane motion model, simulated the geometric characteristic of a deep, narrow valley when slides are initiated high on each valley wall slope. The second, a three-dimensional model, simulated the conditions in more typical valleys, where the wall slopes have an inclination with the horizontal of from 45 to 75 degrees. Model studies were restricted to small scales in which sand-size grains of quartz, or magnetite, were used as the slide material. Geometric scaling was done through three ratios of dimensions. Ratios for the plane motion experiments were 1:2:3 with a maximum height of fall of 6 feet. For the three-dimensional experiments, ratios were 1:1-½:2 with a maximum slope length of 4 feet. Consideration was also given to different variables. Variables considered in the plane motion experiments were volume of slide material, width of slide, height of fall, and physical properties of the slide material such as angle of internal friction, particle size, and particle density. In the three-dimensional studies the angle of inclination of the valley wall slope was also considered. Tests were performed with both models to determine the effectiveness of revetments in controlling critical dimensions of dam profiles. Results indicate that model profiles can be scaled with reasonable success. The width of the slide was found to be one of the most important geometric variables which the designer can control. Particle size was found to be a significant variable. Angle of internal friction and particle density were not proven to be significant variables in the plane motion studies where slide particles have relatively high velocities. The former was found more significant in the three-dimensional studies, where slower particle velocities resulted. Revetments were not found effective. Confidence is expressed that a model study for a given site will reveal the crater configuration required to produce the most favorable dam geometry. Reasonable predictions of slopes, base width, and crest height of dam can also be provided. (auth)

28123 (UCID–15136) PRE-OPERATIONAL REPORT, PROJECT GASBUGGY: GAS QUALITY ANALYSIS AND EVALUATION PROGRAM. Smith, C. F. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 31, 1967. Contract W-7405-eng-48. 20p. Dep. CFSTI.

Operational plans are presented for the attainment of the objectives of the gas quality experiments on Project Gasbuggy. An introduction to the problem of gas contamination is presented, and the expected chemical phenomenology is briefly discussed. Tritium and krypton-85 are the primary problem nuclei. The role of gas analysis in evaluating such procedures as flushing and dilution designed to reduce the contamination level is included. The operational plan calls for analysis of samples taken from the reentry hole GB-ER to obtain information concerning the identity, distribution, and the rate of change of various contaminants which may be in the gas. Analysis of samples taken before, during, and after the production testing, flaring, and dilution experiments will be used to evaluate their effectiveness in reducing the level of contamination. Samples taken from other postshot wells will be used to support analysis of chimney gas samples and to study the migration of activity into the surrounding formation. Anticipated developmental programs required to attain the desired diagnostic capability are outlined. Participants and their responsibilities in the integrated gas-quality program are listed. (auth)

28124 (UCRL–70470) NUCLEAR EXPLOSIONS IN MISSISSIPPI: PROJECTS SALMON AND STERLING. Rogers, Leo A. (California Univ., Livermore. Lawrence Radiation Lab.). June 1, 1967. 8p. Dep. CFSTI.

The theory of decoupling nuclear explosions in underground cavities is discussed in relation to the two nuclear explosions (Projects Salmon and Sterling) fired in the Tatum salt dome in Mississippi. The major conclusions that were reached, most of which were from ten previously published technical papers on the projects, are presented. (auth)

28125 RELATION BETWEEN THE RADIUS AND THE LIFE TIME OF THE CAVITIES CREATED BY SUBTERRANEAN NUCLEAR DETONATIONS. Duclaux, Francoise; Derlich, Serge; Faure, Jean; Ferrieux, Henri; Perrier, Michel (CEA, Hauts-de-Seine, France). Compt. Rend., Ser. A and B, 264: 496-7(Feb. 6, 1967). (In French).

The radius of the cavity formed by a subterranean nuclear explosion and the time which elapses between the detonation and the trenching of the vault of this cavity are related in a linear fashion. An attempt is made to give a theoretical explanation of this law. (tr-auth)

Facilities and Equipment

Refer also to abstracts 28045, 28675, 29079, 29083, 29086, 29153, 29155, and 29186.

28126 (DP–1025-II) PERFORMANCE OF SIEVE TRAYS UNDER GS HEAVY WATER PROCESS CONDITIONS. PART II. HIGH PRESSURE OPERATION. Garvin, Robert G.; Norton, Edwin R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 1967. Contract AT(07-2)-1. 56p. Dep. CFSTI.

Under GS process conditions in a 6½-ft-dia tower, tray flooding limited stable operation to a maximum F-factor of 1.8 at 275 to 280 psig operating pressure. Entrainment over the stable operating range of the trays was less than 0.5 mol liquid per 100 mols gas. (auth)

28127 (IPP–1/59) EINE ARGON KAPILLARENTLADUNG ALS LICHTQUELLE FUER DAS MACH–ZEHNDER INTERFEROMETER. (An Argon Capillary Discharge as a Light Source for a Mach–Zehnder Interferometer). Engelhardt, W.; Koeppendoerfer, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1967. 19p. (In German). Dep.

A high energy capillary discharge in argon was developed as a light source for a Mach–Zehnder interferometer. A delay line charged to about 30 kV is discharged through argon of about 10 atm pressure. The current as well as the light output have rectangular shape lasting 10 μsec long. At wavelengths in the visible the output reaches the intensity of a black body at a temperature of 16,000°K. The dependence of the emission of the light source on different parameters such as pressure, current and charging voltage was investigated. (auth)

28128 (LA-DC-8725) CRYOGENIC RESEARCH AT THE LOS ALAMOS SCIENTIFIC LABORATORY. Hammel, E. F. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 31p. (CONF-670409-2). Dep. CFSTI.

From International Cryogenic Engineering Conference, Kyoto, Japan.

Facilities used in cryogenic research at the Los Alamos Scientific Laboratory for the development of high thrust nuclear propulsion systems for space exploration are discussed. The largest cryogenic test cell is described and cryogenic engineering items such as storage dewars, axial flow pumps capable of attaining 100 atm pressure, H_2O-H_2 heat exchangers, vacuum jacketed transfer lines and flow control systems are discussed. Problems of superconductivity and superfluidity are analyzed. Self-pressurization studies, providing insight into the heat energy distribution in storage dewars are described. (F.S.)

28129 (SC-R-67-1056) INDEX OF PROCEEDINGS OF REMOTE SYSTEMS TECHNOLOGY DIVISION OF AMERICAN NUCLEAR SOCIETY, VOLUMES 1-14. Jefferson, R. M. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 74p. Dep. CFSTI.

The volume is made up of author, corporate author, and subject (keyword) indexes. (D.E.B.)

28130 (UCID-5066) EXPERIMENT IN LONG DISTANCE LASER COMMUNICATION. Nixon, L. S. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 16, 1965. Contract W-7405-eng-48. 20p. Dep. CFSTI.

A 0.5-milliwatt He-Ne laser was used to demonstrate the feasibility of a 35-mile communications link. A mirror arrangement allowed location of source and receiver at a single station. (R.E.U.)

28131 (UCRL-13275) CLEANSWEEP IV, PHASE II. Final Status Report. (General Dynamics/Pomona, Calif.). Feb. 15, 1967. Contract W-7405-eng-48; Subcontract 306. 41p. Dep. CFSTI.

For California Univ., Livermore. Lawrence Radiation Lab.

A summary of the work performed during Phase II of the Cleansweep IV while design program is presented. Primary emphasis is directed toward presenting a review of the mechanical design aspects of the Cleansweep vehicle, and presenting the latest sampling performance estimates of the Cleansweep IV vehicle. Design and fabrication of two prototype Cleansweep IV vehicles was the primary objective of the Phase II program. At program termination, approximately 65% of the vehicle design studies had been completed. Only negligible hardware fabrication and component testing had been undertaken at time of program cancellation. No major design problems were encountered at any time during the program. (auth)

28132 (UCRL-13287) INJECTION MOLDING RESEARCH AND DEVELOPMENT. Final Report, September 30, 1965-September 30, 1966. Salyer, Ival O.; Ball III, George L.; Welch, William E. (Monsanto Research Corp., Dayton, Ohio). Mar. 1967. Contract W-7405-eng-48. 63p. Dep. CFSTI.

For Univ. of California, Livermore.

Quantitative comparisons of hot die and conventional molding techniques with respect to processing characteristics and physical properties of molded parts of polycarbonates were made. Clearly defined process and product advantages of the hot molding technique justify the higher cost, longer cycles, and greater complexity inherent in this process. Favorable results are consistent with the explanation that injection of the carbonate, or other polymer, melt in a die which is above the glass transition temperature, minimizes the tremendous instantaneous increase in melt viscosity, which takes place with injection into a cold die (conventional molding). Gate closure and die sealing can be delayed and molten polymer added during cooling, offsetting volume decrease from thermal contraction during cooling and setting. (F.S.)

28133 CURRENT DIFFUSION IN A SHOCK TUBE WITH VARYING MAGNETIC FIELD. Yasuhara, Michiru (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Jap., 22: 901-5(Mar. 1967).

The electric current-diffusion layer near the current sheet in a magnetic shock tube is analyzed by extending Falk and Turcotte's method to the case in which the driving magnetic field varies with time. Some numerical results for the temperature, velocity, density, pressure and magnetic field are presented in terms of similarity variable when the driving magnetic field varies as a power of time. The results show that the back end of the flowing gas is displaced from its infinite conductivity position by introducing the thermal and electrical conductivities, and the temperature at the back end of the gas becomes finite, the value of which depends on the ratio of thermal to electrical diffusion parameter. (auth)

28134 THICK CYLINDRICAL COIL SYSTEMS FOR STRONG MAGNETIC FIELDS WITH FIELD OR GRADIENT HOMOGENEITIES OF THE 6TH TO 20TH ORDER. Garrett, Milan Wayne (Swarthmore Coll., Pa.). J. Appl. Phys., 38: 2563-86(May 1967).

For strong homogeneous fields the ideal loop and solenoid elements of a prototype system may be expanded into thick cylindrical coils whose current density is (a) uniform or (b) inversely proportional to the cylindrical radius. Error coefficients of the zonal harmonic series for field or gradient that are cancelled in any given prototype continue to vanish as the elements are expanded, even to fusion, if at each stage the coil boundaries are adjusted by an iterative method. This involves the use of (a) the harmonic source functions U_n^* or (b) the Legendre functions P_n; either set is best computed by a recursion formula. An alternative method based on Lyle's principle requires no iterations and only trivial calculations. Though it also is valid for systems of any order, it can only expand a set of loops into coils with square cross sections of limited area. Also, the true null coefficients are replaced by small residues proportional to 4th and higher powers of the section dimensions when the second method is used. The number of tabulated prototype systems of the 6th and 8th orders is increased to more than 200. Since multiply infinite sets of prototypes can be computed for every order higher than the 8th, univariate tables would be inadequate and only a few illustrative examples of such systems are given. Some 150 thick-walled systems of the 6th or 8th order are listed in several tables, but such a selection can only suggest the wide range of possibilities. These systems have more degrees of freedom than do the corresponding prototypes, and even the 6th order is multivariant. At the 8th order and beyond, the growing redundancy of variables permits the design of systems with a common current density in all coils and with all section dimensions proportional to a set of small integers. Systems of order 4n have paired coils with gaps for lateral access, an advantage that is lacking in the 6th-order designs. Efficient computer programs have been written to design systems of all the types so far enumerated, including multiple sets of both prototypes and fully adjusted systems of thick coils for orders from 8 to 20 in steps of 4. Since adequate tabulation of results is ruled out by their diversity and sheer bulk, in view of the wide range of potential applications the programs themselves must be considered the basic research tool. They will be described in detail elsewhere. As a measure of field inhomogeneity, including contributions from all orders and from both axial and radial field components, the concept of total vector error is developed. The tables include error limits for all systems, and some 40 systems or their error contours are shown in the figures. (auth)

28135 EMERGENCY GAS TURBINES FOR OLDBURY, THREE 2.5MW SETS IN SERVICE. Elec. Times, 151: 378-9 (Mar. 9, 1967).

The emergency power supply system for the 600 MW(e) nuclear power station is described. Each set comprises an open-cycle, twin shaft, Proteus gas turbine developing 4,250 hp. The 1,000 rpm, 50 cps alternator is driven by an independent two-stage axial low pressure turbine. Kerosene fuel is used to avoid cold starting problems. (UK)

28136 REGULATOR FOR PROPORTIONAL COUNTER ON A DIAGNOSTIC ROCKET (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1579). 15 drawings.

A regulator is described which is able to maintain a constant pressure in a proportional counter and with the opening of a solenoid valve, quickly replace the counter gas and flush out the contaminated gas. Set pressure can vary during flushing but the regulator must return the counter to the original pressure when gas flow stops. The regulator maintains the set pressure during flight, launch, atmospheric exit, linear acceleration, vibration, changing ambient pressure, and free fall. The regulator incorporates two stages of pressure reduction and a relief valve. The first stage reduces pressure to 30 psig and the second to the 15 to 20 psig range. The relief valve controls the upper limit of the set pressure. (For details see TID-4100 Suppl. 40). (F.S.)

28137 ATR FUEL ELEMENT, MARK VI (Engineering Materials). (Idaho Nuclear Corp., Idaho Falls). (CAPE-1578). 82 drawings.

Advanced Test Reactor fuel elements are described which have 19 fuel bearing plates attached to two Al alloy side plates by mechanical means. End adapters are attached to the fuel section by welding. The two Al alloy combs are attached to the fuel plates by pinning and tack welding. The fuel loading is 975 ± 10 g of ^{235}U in each fuel element and the ^{10}B loading is 0.810 ± 0.02 g. The fuel plates consist of UAl_3 intermetallic powder and natural B_4C powder dispersed in x8001 Al alloy powder. A fuel inspection gage is also described which is used in fuel element dimension checking. (For details see TID-4100 Suppl. 40). (F.S.)

28138 ENERGIEVERSORGUNG IM WELTRAUM. Herausgegeben von der Deutschen Gesellschaft fuer Raketentechnik und

Raumfahrt e.V., Stuttgart, 8 Dezember 1965. (Symposium on Energy Production in Space. German Society for Rocket Technology and Space Travel, Stuttgart, December 8, 1965). Wursthorn, Armin M. Fortschritte in der Raumfahrtforschung, Band 2. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. 285p. $7.00. (CONF-651219).

The 14 papers presented at the symposium on energy production in space at Stuttgart are compiled. Individual abstracts were prepared for 11 papers. (J.S.R.)

For abstracts of individual papers see: 28139, 28172, 28173, 29079–29085, and 30241.

28139 DEVELOPMENT OF THERMOMECHANICAL ENERGY CONVERTERS FOR 500 W(e). Stegmann, W. (Junkers Flugzeug- und Motorenwerke AG, Munich). pp 189-219 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

A thermomechanical energy converter for 500 W(e) was developed. The parameters used in the development of the converter were outlined. The individual units in the construction of the converter, the testing program, and the design viewpoint are outlined on the basis of illustrations. (J.S.R.)

28140 ANALYTICAL BETA IRRADIATION DEVICE. Fukai, Junichiro (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-11120. May 24, 1966. Filed Mar. 6, 1963.

In the analytical β-ray irradiation device proposed, a beta ray focusing cylindrical body is provided that includes a beta source, a sample material irradiated with the beta rays, a detector for the characteristic x-rays from the irradiated material, and a beta ray focusing cylindrical body located in the path of beta rays (from the source to the sample material), which also shields the beta rays from foreign magnetism. (NSA of Japan)

28141 NEUTRON IRRADIATION DEVICE. Miyoshi, Katsuhiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9279. May 4, 1966. Filed Sept. 15, 1962.

A neutron irradiation device is proposed in which samples are irradiated with neutrons produced by target bombardment with accelerated particles, the plurality of samples can be irradiated uniformly with the neutrons. The neutron irradiation device, as is usual, includes the following: a cylindrical body attached on top of the accelerating tube through an annular insulator; the neutron-producing target held onto the top of this cylindrical body; the plurality of samples irradiated by the produced neutrons; and a device for measuring the amount of produced neutrons by means of the current at the target. The terminal rod for measuring the (electric) current is installed axially (with respect to the accelerating tube, etc.) within the walls of the target holding cylindrical body, annular insulator and (the end of) the accelerating tube. Consequently, a hollow cylindrical body in the wall of which the plurality of samples are inserted can engage with the target holding cylindrical body, with the latter within the former, and the sample holding cylindrical body can be rotated for the uniform irradiation of samples. (NSA of Japan)

28142 TARGET FOR A NEUTRON GENERATOR. Ogawa, Kazuyuki (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9748. May 25, 1966. Filed Mar. 12, 1965.

An improved zircon or titanium hydride target, which has a long life, is proposed for use in a neutron generator. The target as a whole consists of a top-open container in which a hydride evolving deuterium or tritium gas by decomposition is contained, and the target proper which serves as the lid to the container. The (target) lid is made of a porous metal, and the outer surface of it is coated with a film of titanium or zirconium. The lid may be made of a porous, sintered metal containing titanium or zirconium. (NSA of Japan)

28143 IMPROVED MACHINE TOOL. (to Commissariat a l'Energie Atomique). British Patent 1,071,625. June 7, 1967. Priority date Nov. 19, 1963, France.

A combined screw-cutting lathe and a multi-cutter milling machine of possible use in the manufacture of multi-flanged sheaths for reactor fuel elements is described. The device is capable of forming grooves of any section and of rectilinear or helical shape in workpieces to form flanges defined by two adjacent grooves with variable inclination of rectilinear grooves or variable pitch of spiral grooves. (R.E.U.)

28144 HOT LABORATORIES. D'Arcy, J. (ed.). London, British Nuclear Forum, 1966. 44p.

The following topics are covered: philosophy of hot laboratories, shielding, glove boxes, remote handling, viewing, monitoring, ventilation, decontamination, waste handling, and in-cell equipment. (UK)

28145 REMOTE CONTROL MANIPULATORS. (to Atomic Energy of Canada Ltd.). British Patent 1,070,056. May 24, 1967. Priority date June 23, 1964, United States.

A remote-control manipulator is described for particular application to a remote-control welding tool for internal repairs of an apparatus such as a nuclear reactor in which it is impossible to have an operator at the site of repairs, but the manipulator is not restricted to this use only. The manipulator is described in detail with reference to other applications. (B.L.M.)

28146 IMPROVEMENTS RELATING TO IRRADIATION. (to Sulzer Brothers Ltd.). British Patent 1,070,682. June 1, 1967. Priority date Apr. 20, 1964, Switzerland.

An irradiation facility is described which includes means for conveying the material to be irradiated past the source in batches and provides for periodically interrupting the movement of the conveyor by stationary periods. The drive mechanism for the conveyor system is provided by an electric motor having a high switching frequency. A timer having an adjustable dead time is included in the facility. (B.L.M.)

Heat Transfer and Fluid Flow

Refer also to abstracts 28169, 28716, 28771, and 30239.

28147 (AEEW-R-506) A VISUAL STUDY OF FORCED CONVECTION BOILING. PART 2. FLOW PATTERNS AND BURNOUT FOR A ROUND TEST SECTION. Kirby, G. J.; Staniforth, R.; Kinneir, J. H. (Atomic Energy Establishment, Winfrith (England)). Mar. 1967. 30p. Dep. CFSTI. UK 5s.

Studies of boiling water at 25 lb/in.^{2} abs indicate the same flow patterns as earlier tests. Bubbles formed on the heater remained close to the heated surface and coalesced into large bubbles which eventually spanned the flow channel. The flow pattern at burnout was dependent on the degree of subcooling; at high subcooling only nucleate bubbles were present, whereas at low subcooling the channel was full of large vapour bubbles. In the former case the burnout heat flux was dependent only on local conditions. (auth)

28148 (AERE-R-5402) EXPERIMENTS ON LARGE GAS BUBBLES IN LIQUIDS. Collins, R. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 40p. Dep. CFSTI. UK 7s.

Experiments performed to ascertain the effect of a containing cylindrical boundary on the velocity of a large gas bubble in a liquid were found to agree well with theoretical predictions of velocity expressed in terms of the apparent radius of curvature of the bubble cap. An empirical relation between cap curvature and bubble volume allows the theory to be recast as a semi-empirical theory relating velocity with volume, in which form it agrees with experimental results obtained by previous investigators, but the relation between volume and curvature obtained does not agree with that employed by Uno and Kintner (1956). It is argued that further work would be necessary before the application of the present results to bubbles in fluidized beds can be justified. Tabulated results from both this and previous investigations are given. (auth)

28149 (AERE-R-5415) ROUGH TUBE FRICTION FACTORS AND HEAT TRANSFER COEFFICIENTS IN LAMINAR AND TRANSITION FLOW. Molloy, J. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 28p. Dep. CFSTI. UK 4s. 0d.

An experimental program on friction factors and heat transfer from smooth and rough tubes is described. Experiments were carried out at low Reynolds numbers (1,400 to 40,000), and the results are compared with other experimental data and with a theoretical analysis of laminar flow heat transfer. In the laminar regime the behavior of both types of surface was found to be identical. Beyond the critical Reynolds' number the Stanton number for the roughened tube rose continuously with Reynolds' number over the range tested (up to Re $\approx$ 8000), whereas that for the smooth tube passed through a maximum. The friction factor data indicated a range in the transition region where the rough tube could actually give a lower value than the smooth tube. (auth)

28150 (GEAP-5414) PREDICTION OF THE VOID FRACTION IN SUBCOOLED BOILING, ANNULAR FLOW, AND IDEAL BUBBLY FLOW: ASSIGNMENT REPORT USAEC–EURATOM PERSONNEL EXCHANGE, MAY–DECEMBER 1966. Staub, F. W. (General Electric Co., Schenectady, N. Y. Research and Development Center). Jan. 1967. Contract AT(04-3)-189. 116p. (EURAEC-1852). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The derivation of a set of relations which permit the prediction of the initial point of net vapor generation is presented and satisfactory agreement with data is shown over a large range of fluid velocity, reduced pressure and for two different fluids. A semi-empirical formulation for the light phase drift velocity in annular

flow is given and compared to the data. The method for the calculation of the void fraction in ideal bubbly flow is reviewed, extended and compared to data in both ideal and turbulent bubbly flow conditions. (auth)

28151 (K-1695) NUMERICAL TREATMENT OF A THIN PLATE HEAT TRANSFER PROBLEM. Stewart III, G. W.; Lick, Dale W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 31, 1967. Contract W-7405-eng-26. 18p. Dep. CFSTI.

The numerical solution of a system of linear equations resulting from a discrete approximation to a thin plate heat transfer problem is reported. The slow convergence of a standard iterative method is analyzed and shown to be caused by one of the boundary conditions. A line iterative method which removes the difficulty is described. (auth)

28152 (LA-DC-8679) LAMINAR-NONLAMINAR TRANSITION FOR NON-NEWTONIAN FLOW IN ANNULI. McEachern, Donald W. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 21p. (CONF-670506-2). Dep. CFSTI.

From 62nd National Meeting of The American Institute of Chemical Engineers, Salt Lake City, Utah.

Experimental results on the laminar-nonlaminar transition of aqueous solutions of hydroxyethyl cellulose in axial, isothermal flow in annuli are presented. For each polymer solution the end of the laminar regime is observed to occur at different flow rates at different axial distances from the entrance of the test section. For some polymer solutions in nonlaminar motion, the pressure gradient is not constant over the length of the test section. These data on transition in annuli are compared with predictions made using Hanks' transition criterion where (1) only viscous contributions are considered and (2) where viscous effects are considered and elastic effects accounted for approximately. Predictions where both viscous and elastic properties of the fluids are considered are in fair agreement with experiments. Predictions using purely viscous theory are less accurate. (auth)

28153 (NASA-TN-D-4020) STEADY-STATE PERFORMANCE OF A SEVEN-TUBE NaK-COOLED POTASSIUM CONDENSER. Fenn, David B.; Acker, Loren W.; Coe, Harold H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1967. 39p. CFSTI.

Potassium vapor was condensed inside the tubes of a horizontal, multitube heat exchanger. The tubes were cooled with the liquid metal sodium potassium (NaK) flowing in a countercurrent direction in the space surrounding the tubes. Steady-state data are presented to show the effects of NaK coolant inlet temperature and coolant flow rate on the condensing length, the coolant temperature profiles, and the overall pressure drop of the condenser over a range of potassium inlet temperatures from 1200° to 1500°F. A correlation of the overall pressure drop on the potassium side of the condenser was obtained by plotting the ratio of the measured overall pressure drop to the velocity head in the tube inlet as a function of the condensing-length-to-diameter ratio. (auth)

28154 (ORNL-TM-1877) AN EVALUATION OF RECENT STUDIES OF HIGH-FLUX HEAT TRANSFER TO GASES. Gambill, W. R. (Oak Ridge National Lab., Tenn.). May 24, 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

A review was made of the literature of the past decade in order to collect quantitative information relevant to the transmission of heat to flowing gases at high heat fluxes (defined here as a maximum experimental flux of at least 0.5×10^6 Btu/hr·ft^2). The available data include heat-transfer-coefficient determinations for He, H_2, and N_2 in tubular, parallel-plate, and wire-mesh geometries for pressures of 15 to 1511 psia, Reynolds numbers of 2.0×10^3 to 1.5×10^6, maximum heat fluxes of 0.58×10^6 to 7.68×10^6 Btu/hr·ft^2, and maximum surface and bulk coolant temperatures of 5440°F and 4180°F, respectively. The correlations proposed for heat-transfer coefficients are reviewed and a recommendation made for turbulent internal duct flow. Graphical results are given which directly relate surface temperature to heat flux for helium flowing through a 0.5-in.-diam tube at mass velocities of 10^4 to 10^5 lb/hr·ft^2 and at bulk temperatures of 200 to 4000°R. Friction data are also reviewed and a correlation recommended for the computation of friction factors up to a temperature ratio of ~8. (auth)

28155 (SC-RR-67-142) ANALYSIS OF HEAT TRANSFER AND BOUNDARY LAYER TRANSITION ON A BLUNT BODY AT HYPERSONIC SPEEDS. Maydew, R. C. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 39p. Dep. CFSTI.

Local pressures and heat transfer rates were measured on a flat-nose, cone-cylinder-flare model in a hypersonic shock tunnel at Mach numbers of 6.6 to 8.0 and Reynolds numbers of 0.8 to 35×10^6/ft. The cone-cylinder heat transfer data correlate with the theories of Van Driest for the laminar boundary layer and Spalding and Chi for the turbulent boundary layer. The local Reynolds number at the beginning of transition, based on wetted length from the stagnation point, was approximately 0.2×10^6 on both the conical and cylindrical sections. (auth)

28156 (SGAE-RT-9/1967) FUNDAMENTALS OF HEAT EXCHANGER DYNAMICS WITH SPECIAL ATTENTION TO DOUBLE TUBE HEAT EXCHANGERS. Eigner, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Reaktorentwicklung). Jan. 1967. 15p. (CONF-660654-1).

From 3rd Congress of the International Federation of Automatic Control, London, England.

Fundamental equations of the general heat field are described. The dynamics of double tube heat exchangers are evaluated and suggestions are made for obtaining a more exact and satisfactory agreement between theory and experiment by deriving a more realistic velocity field depending on space and time. (F.S.)

28157 (WAPD-T-1824) FLOW PATTERNS IN HIGH PRESSURE TWO-PHASE (STEAM-WATER) FLOW WITH HEAT ADDITION. Hosler, E. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 42p. (CONF-670807-1). Dep. CFSTI.

From 9th National Heat Transfer Conference, Seattle, Wash.

The flow patterns that occur in forced flow vaporization of water at high pressure were observed and photographed. A vertical rectangular channel $\frac{1}{8}$ in. thick × 1.0 in. wide × 24 in. long heated from one side, the other three sides being used for observation of the flow phenomena, was used for the experimental investigation. The ranges of variables covered include: pressure 150 to 2000 psia; mass velocity 0.10×10^6 to 4.0×10^6 lb/hr-ft^2; heat flux up to 1.8×10^6 Btu/hr-ft^2; quality subcooled to 0.70. The flow patterns observed included bubble, slug-type, annular, spray-annular, and wave flow. Comparisons were made between observed flow pattern transitions and several published flow pattern maps, based generally on adiabatic flow. The differences between two-phase adiabatic flow and two-phase flow with heat transfer are noted. Preliminary empirical flow regime maps for use with narrow rectangular channels are presented. (auth)

28158 (AD-645794, pp 121-30) HEAT TRANSFER WITH TURBULENT FLOW OF MERCURY IN NARROW ANNULAR CHANNELS. Petrovichev, V. I. Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1959.

Experimental results are represented of the heat transfer of mercury in narrow annular channels for two ratios of external to internal diameters (1.42 and 1.77), for the case of external heating under conditions of constant thermal load on the external tube wall. Experimental data for length averaged heat transfer coefficients are treated on the basis of equivalent hydraulic diameter. The possibility to calculate heat transfer for the given case on the basis of usual formulas for heat transfer of liquid metals in smooth round pipes is demonstrated. (auth)

28159 (NASA-TT-F-432) NON-STATIONARY HEAT AND MASS TRANSFER. Gurevich, I. G.; Zhuk, I. P.; Kondrashov, N. G. (eds.). Translation of Voprosy Nestatsionarnogo Perenosa Tepla i Massy, Nauka i Tekhnika, Minsk, 1965. 144p. (TT-67-51368; IPST-Cat.-1817). CFSTI.

A collection of 19 papers dealing with nonstationary (unsteady-state) heat and mass transfer problems encountered in various branches of science and technology is presented. Analytical solutions of unsteady-state heat and mass transfer equations applied to practical problems are described. Data which were obtained in experimental investigations of heat and mass transfer under unsteady conditions are correlated. (F.S.)

28160 STABILITY CONSIDERATIONS IN TWO-PHASE FLOW. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Nucl. Sci. Eng., 28: 317-24(June 1967). (BNL-10538).

A spatial-averaged model of boiling flow in an electrically heated vertical pipe was used to investigate and explain experimental data of various laboratories. The agreement with data was good over a variety of conditions ranging in pressure from atmospheric to 1000 psia, and in heated length from 2 to 16 ft. Two slip-ratio correlations were compared in testing the model against the stability data. The crucial boiling length, where the system is least stable, was used to demonstrate the dependence of stability on heating rate, flow rate, and degree of subcooling. In particular, it is shown that with the Bankoff–Jones slip ratio, an increase in the ratio of heating rate to flow rate invariably leads to less stable conditions. On the other hand, an increase in subcooling leads to less stable conditions only when the degree of subcooling is less than that at the crucial boiling length. (auth)

28161 SUPERHEATING AND SINGLE BUBBLE EJECTION WITH THE VAPORIZATION OF STAGNATING LIQUID METALS. Spiller, K.-H.; Grass, G.; Perschke, D. (EURATOM, Ispra, Italy). Atomkernenergie, 12: 111-14(Mar.-Apr. 1967). (In German).

Potassium was heated by direct current above the boiling point and the boiling superheat was measured. Due to the heating technique employed surface roughness elements normally acting as nucleation centres could be made largely inactive. Chemico-physical impurities likely to promote nucleation were removed employing special purification procedures. Under these extreme conditions boiling superheats in the range 70 to 820°C were measured. It was shown that during the bubble expansion a superheated layer of potassium having a thickness of 0.07 to 0.23 mm adheres to the wall. The evaporation of this layer may be responsible for the continuing expansion of the vapour space. (auth)

28162 BOILING OF LIQUID ALKALI METALS. Grass, G.; Kottowski, H.; Warnsing, R. (EURATOM, Ispra, Italy). Atomkernenergie, 12: 101-10(Mar.-Apr. 1967). (In German).

Boiling of liquid metals at low pressures is of an unstable nature under stagnant conditions as well as under conditions of natural and forced convection. This unstable type of boiling may be interpreted as an ejection sequence of single bubbles. The kinetics involved in this ejection process are significantly influenced by the vapor pressure in the bubble. The latter depends largely on the initial superheat of the liquid which amounted for the present experimental conditions to 85°C for circulating potassium and to 130°C for stagnant potassium. During the expansion the pressure in the vapor space sinks from a high initial value, apparently due to the fact that not sufficient vaporization occurs. In the work here described initial superheat, initial pressure and subsequent pressure variations, were for various experimental conditions compared with the kinetics of the single bubble ejections. A calculation model was set up to correlate quantitatively the phenomena. (auth)

28163 AN ANALYTICAL AND EXPERIMENTAL STUDY OF BURNOUT CONDITIONS IN VERTICAL ROUND DUCTS. Becker, K. M. (Royal Inst. of Tech., Stockholm). Nukleonik, 9: 257-70 (Apr. 1967).

An analysis for predicting the burnout conditions for boiling water flow in vertical round ducts is presented. The analysis, based on the Vanderwater flow model, predicts that the burnout conditions are independent of the inlet sub cooling and the heated length, and depends only on the local values at the burnout position of pressure, heat flux, steam quality and mass velocity, and the duct diameter. The results of an experimental investigation covering 811 burnout measurements in the pressure range from 41 to 101 kg/cm^2 is presented. These results together with 488 of our earlier burnout measurements at the pressures of 2.7, 10, 20 and 30 kg/cm^2 were used to determine two constants in the analytical results. The final correlation predicted the burnout heat fluxes of the 1299 measurements within ±8% and with an RMS error of 5.3%. The Columbia data and Winfrith data were also analysed in terms of the measured and predicted burnout heat fluxes and enthalpies, and it was found that a very good agreement existed. The Columbia data were on the average 3% lower; the Winfrith data were on the average 6% higher. (auth)

28164 TRANSIENT RESPONSE OF AN INTRINSIC THERMOCOUPLE. Henning, C. D.; Parker, R. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Heat Transfer, 89: 146-54(May 1967). (UCRL-14862).

Where rapid heating is encountered, as in a prompt-burst nuclear reactor, a thermocouple with a rapid time-response is necessary to monitor the temperature of the specimen in question. Because all thermocouples have some mass, they cannot have an infinitely fast response. However, an intrinsic-type thermocouple has less thermal inertia than the usual welded-bead type. Thus it is a natural choice for the measurement of transient surface temperatures of conducting solids. An analytical expression is obtained for the transient response of an intrinsic thermocouple. In support of the analysis, experimental data are presented which were obtained by means of a capacitor bank pulse-heating technique. It is concluded that thermocouple wires of small diameter and low thermal conductivity respond the fastest. As an example, a 1-mil constantan wire on a copper substrate produces 95 percent of the steady-state emf in 3 μsec. (auth)

28165 TEPLOOBMEN I GIDRO-DINAMIKA V DVUKHFAZNYKH SREDAKH. (Heat Exchange and Hydrodynamics in Two-Phase Media). Dorfman, A. Sh. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. 108p.

Thirteen articles are presented on experimental studies of heat transfer during surface boiling and critical heat transfer in channels of various shapes in heat exchangers. The mechanism of the heat transfer process, the intensity of heat transfer during boiling and condensation of fluids, heat exchange during boiling of binary mixtures, and the influence of centrifugal forces and vibrations on the heat exchange process are described. (R.V.J.)

28166 ANALYSIS OF ENGINEERING CYCLES. Haywood, R. W. The Commonwealth and International Library. New York, Pergamon Press, 1967. 290p. $5.00.

Complete analyses of overall performance, under design conditions, are given of simple power and refrigeration plants (power plant performance parameters, simple steam plant, simple closed-circuit gas-turbine plant, internal-combustion power plant, and simple refrigerating plant) and of advanced power and refrigerating plants (advanced gas-turbine plant, advanced steam-turbine plant, nuclear power plants including both gas- and liquid-cooled reactors, combined and binary plant, and advanced refrigerating and gas-liquefaction plant). The text was prepared for engineering thermodynamics students, teachers, and practicing engineers. (R.E.U.)

28167 PROCEEDINGS OF THE 1967 HEAT TRANSFER AND FLUID MECHANICS INSTITUTE HELD AT THE UNIVERSITY OF CALIFORNIA, SAN DIEGO, LA JOLLA, CALIFORNIA, JUNE 19, 20, 21, 1967. Libby, Paul A.; Olfe, Daniel B.; Van Atta, Charles W. (eds.). Stanford, Calif., Stanford University Press, 1967. 476p. $12.50. (CONF-670212).

Papers are presented on various aerospace aspects of heat transfer and fluid mechanics. Approximately two-thirds of the papers deal with Post-Apollo reentry phenomena and propulsion fluid mechanics and heat transfer. Other topics discussed are: vortices, wakes, and boundary layers. (J.H.M.)

Isotope Technology

Refer also to abstracts 27928, 28138, 28155, 28238, 29080, 29082, and 30239.

28168 (BMwF-FBK-67-26) UEBER DIE ISOTOPENANREICHERUNG MIT DER MOLEKULARSTRAHL-TRENNSCHLEUSE. (Some Investigations on Isotope Separation by the Molecular Beam Chopper Method). Rees, J. (Kiel Univ. (West Germany). Institut fuer Angewandte Physik). Apr. 1967. 8p. (In German). Dep.

A brief review is given of different molecular beam units. A higher experimental simple-process factor of a special, continuously working molecular beam unit is described. The continuous separation of that unit is made possible by using turbo-molecular-pumps. The simple-process factors were measured using CO_2. (auth)

28169 (MND-3607-93(Vol.1)) DISTRIBUTION OF HEAT AND PRESSURE ON THE SNAP 19 FUEL CAPSULE IN HYPERSONIC FLOW. Lambert, W.; Coughlin, T. (Martin Co., Baltimore, Md.). Mar. 1967. Contract AT(30-1)-3607. 247p. Dep. CFSTI.

Hypersonic pressure and heat transfer rate distribution tests on the SNAP-19 fuel capsule were conducted in the NASA Langley Research Center 31-inch Continuous Flow Hypersonic Tunnel. The objectives were to test theoretical methods of predicting the re-entry behavior of the fuel capsule. Data were ascertained for a nominal Mach number of 10, Reynolds number range of 0.5×10^6 to 1.7×10^6 per foot, and over an angle of attack of 0° to 90°. Two full-scale fuel capsule models were utilized, one for obtaining pressure data, and the other for obtaining the temperature histories necessary in finding heat transfer rates. (D.L.C.)

28170 (NYO-2757-6) DEVELOPMENT OF ^{85}Kr AS A UNIVERSAL TRACER. Final Report, December 1, 1964-November 30, 1966. Cucchiara, Orlando; Goodman, Philip (Parametrics, Inc., Waltham, Mass.). May 1967. Contract AT(30-1)-2757. 30p. Dep. CFSTI.

WEAR — analysis using krypton-85-labeled solids
PHOSPHORS — preparation of krypton-85 excited
CALCIUM SILICATES, ZINC SILICATES, ZINC SULFIDES, ZINC GERMANATES, CADMIUM CHLOROPHOSPHATES, STEEL — krypton-85 incorporation in
HYDROGEN — detection using krypton-85-labeled platinum dioxide sensors
KRYPTON-85 — incorporation into solids; use as tracer (D.E.B.)

28171 (SGAE-IB/IA-14/1967) LEITISOTOPENVERSUCHE ZUR KONTROLLE VON BITUMENUNTERPRESSUNGSARBEITEN AN DER AUTOBAHN. (Tracer Isotope Experiments for the Control of Bitumen Work Pressure on the Autobahn). Duftschmid, K. E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1967. 11p. (In German). Dep.

On heavily traveled concrete highways, cavities below the road-surface often occur. This is caused by the rocking motion of the

concrete slabs and the squeezing out of the sand foundation. In such cases bitumen is injected by grouting holes drilled through the slabs to avoid damage. A tracer method for measuring the extension, shape and thickness of such injected bitumen layers is described. The bituminous material is labeled with ^{24}Na-naphthenate dissolved in heavy oil. The gamma radiation on the road surface is measured by a portable scintillation counter which is mounted on a handcart. The method has been tested in preliminary experiments using concrete slabs of similar dimensions as on the highway (10 × 3.75 × 0.22 m). The slabs were partly coated with various layers of labeled bitumen and then turned over with a crane. By gamma-scanning on the opposite side the shape of the coats could be determined within an accuracy of approximately ±2 cm. In the full-scale operation the radioactive tracer is mixed with the bitumen using a rotary-type boiler. A specific activity of 20 mCi/t was proved to be sufficient for measuring layers down to 1 mm thickness. The method is suitable for routine use and makes possible an accurate control of the repair work as well as considerable savings of time and material. (tr-auth)

28172 ENERGY SUPPLY INSTALLATIONS WITH NUCLEAR ENERGY SOURCES. Pruschek, R. (Technische Hochschule, Stuttgart). pp 103-33 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The properties of nuclear energy sources such as radioisotopes and nuclear reactors are described with respect to their applicability as energy supply sources for space craft. The properties of various energy converters and the problem of their construction together with the nuclear heat source are discussed. The present state of nuclear energy power sources and the development tendencies were considered. (tr-auth)

28173 LIMITS OF THE RANGE OF APPLICATION OF RADIOISOTOPE SOURCES AND NUCLEAR REACTORS AS ENERGY SOURCES FOR SPACE VEHICLES. Einfeld, K.; Lauffher, R. A. (INTERATOM, Bensberg, Ger.). pp 135-49 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The applicability limits of reactor and radioisotope systems should be defined with respect to their output. In addition to shielding and safety requirements, power, weight, and system costs are to be considered in the transportation cost of different carrier rockets. Radioisotopes are therefore considered in this respect on the basis of their physical properties, availability, cost, and shielding and safety requirements. The characteristic variations of both energy sources were discussed. Three power ranges are indicated from which only the middle range with initial power of several hundred watts up to several kW were considered under sharply limited assumptions on both nuclear power systems. (tr-auth)

28174 PREPARATION OF THE ^{86}Kr ISOTOPE LAMP. Tako, Toshiharu (National Research Lab. Metrol., Tokyo). Keiryo Kenkyu-Sho Hokoku, 16: 52-7(Jan. 1967). (In Japanese).

The procedures and practices involved with production of the Kr-86 hot cathode lamps used as primary standards at the National Research Laboratory of Metrology are described. (TSS)

28175 THE TECHNICAL APPLICATIONS OF RADIOACTIVITY. VOLUME I. Broda, E.; Schoenfield, T. Oxford, Pergamon Press, 1966. 353p. 105s.

The fundamentals and measurement of radioactivity are discussed, together with the production and chemistry of radioelements, and the use of radioactive tracer methods. Applications include chemical analysis, mining and oil production, metallurgical, engineering and electrical industries, general problems of the chemical industry, agriculture and forestry, and hydrology and water supply. A section is included on radiation protection. (UK)

28176 RADIOISOTOPE MEASUREMENT APPLICATIONS IN ENGINEERING. Gardner, Robin P.; Ely, Ralph L. Jr. New York, Reinhold Publishing Corp., 1967. 495p. $16.00.

Engineering applications of radioisotopes for nuclear measuring techniques are discussed. Subjects covered include radioactive decay processes, nuclear reactions, tracer techniques, radiation detection systems, radiation safety, radiogaging, and radiography. Fifteen laboratory experiments are included which are suitable for performance by college seniors or graduate students in engineering. (F.S.)

28177 RADIOIZOTOPY V STROITEL'STVE FUNDAMENTOV I PODZEMNYKH SOORUZHENII. (Radioisotopes in Foundation Constructions and Underground Installations). Smorodinov, M. I. Moscow, Atomizdat, 1967. 156p.

The use of radioactive isotopes in foundation construction and underground installations is examined. Examples of the use of radioisotopes for increasing the productivity of plants and automation of industrial processes are reported. Apparatus and equipment used for obtaining raw data during the design of underground installations are described. The radioactive tracer method used to study stressed masses in a nondestructive manner and to make a selection of the optimum parameters of instruments and work regimes for underground cycle machines is also described. (tr-auth)

Materials Testing

Refer also to abstracts 28757 and 28798.

28178 (LA-DC-8272) NONDESTRUCTIVE TESTING OF GRAPHITE AT THE LOS ALAMOS SCIENTIFIC LABORATORY. Blanks, B. L.; Edenborough, N. B.; Elliott, D. E.; Ford, R. M. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 36p. (CONF-670605-2). Dep. CFSTI.

From 70th Annual Meeting of the American Society for Testing and Materials, Boston, Mass.

The applications and limitations of radiography, ultrasonics, sonics, eddy current, radiation gaging, and beta-backscatter gaging for the inspection of graphite and its protective coatings are reviewed. The use of ultrasonics, sonics, eddy current, and radiation gaging to determine physical characteristics, aside from the normal flaw detection shows promise in the inspection of graphite. Electron microscopy has proved to be a valuable tool for the evaluation of the findings of nondestructive testing. (auth)

28179 (PSDC-TR-19) ULTIMATE STRENGTH OF CHOPPED WIRE REINFORCED SMALL SCALE MORTAR SLABS. Final Report. Lamb, Herbert C.; Dembo, Michael M. (Protective Structures Development Center, Fort Belvoir, Va.). Jan. 1967. 61p.

Small scale concrete slabs reinforced with chopped wire were tested to determine ultimate strength and failure mechanism. Special techniques for adding the chopped wire were required to obtain a uniform and workable mix. Best results were obtained by blowing the 0.5 inch lengths of 6 mil wire into the mixer as the wire was sifted slowly through a screen. Three slabs were cast at Carnegie Institute of Technology and shipped to the PSDC for testing and eight were cast at the PSDC. The nominal thickness of the test slabs varied from $\frac{1}{2}$ to $\frac{3}{4}$ inch. All slabs were 30 inches square and supported on rollers at $29\frac{1}{4}$ inches. Uniformly distributed static loads were applied using a vacuum loading apparatus. Increasing the reinforcement from 2 to 4% by volume did not increase the strength of the slabs. Slabs containing 2% reinforcement had greater ultimate strength than predicted while those with 0 and 4% failed at lower than predicted loads. (auth)

Protective Structures

28180 (ORNL-TM-1823) VISCOUS ATTENUATION OF EXPLOSIVE SHOCKS IN TUBES. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Measurements of shock arrival time and peak overpressure were made at distances up to 165 dia down shock tubes. At these distances, viscous drag at the walls markedly attenuates shock waves. Laws of propagation of plane blast waves are calculated for very strong and very weak shocks. Sources of error in numerical calculations of explosive shock propagation in the presence of the frictional force are discussed. Experimental results were compared with theoretical calculations and it was found that flow in explosive driven shock tubes is well described in the model used and that the friction factor in a 4 in. shock tube is ~0.008 and the transition to turbulent flow occurs at ~50 dia down the tube. (F.S.)

28181 SCATTERING OF FALLOUT RADIATION FROM CEILINGS OF PROTECTIVE STRUCTURES. Kimel, W. R.; Faw, R. E.; Baran, J. A.; Mingle, J. O.; Rubin, R. M.; Iotti, R. C.; Urban, W. T. (Kansas State Univ., Manhattan). Kans. State Univ., Eng. Exp. Sta., Bull., Special Report No. 72, 1-168 (July 1966).

A thorough study of the ceiling scattered fallout radiation (ceiling shine) problem has been made. Ceiling shine is defined to be that contribution to the radiation dose rate in a protective structure resulting from fallout radiation entering the structure through apertures in vertical walls and scattering downward from the ceiling. A systematic analytical analysis of this problem, verified experimentally, resulted in a set of design curves. These curves yield the ceiling shine reduction factor in any concrete structure as a function of building dimensions, size and location of apertures, and detector location. (auth)

Radioactive Material Handling

Refer also to abstract 28144.

28182 (BNWL-410) FIXATION OF RADIOACTIVE RESIDUES. Research and Development Activities Quarterly Progress Report, October–December 1966. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

The final spray solidification test in WSEP before introducing radioactivity was only partially successful. High filter pressure drop and wall deposition were discovered, but the cause was not identified. The first conversion of highly radioactive liquid waste to solids by pot calcination was successful. Condensate decontamination was adequate to produce drinking water levels of activity. Subsequent evaluation of the pot and contents indicated thermal conductivity to be within expected volumes. No pressurization has occurred in the sealed pot. Use of an excess of phosphoric acid in the continuous phosphate glass process produced an inoperable condition using PW-1 waste. Some platinum corrosion was evident in the off-gas line. Structural design and expansion adjustments were inadequate to prevent distortion of platinum nozzles. Corrections are being made. Free-flowing asphalt product containing 60 wt % waste solids was prepared with neutralized, simulated, glass melter condensate. Cesium-137 leach rates from the asphalt product in distilled water at 25°C were 6×10^{-5} g cm^{-2} d^{-1} and 3×10^{-5} g cm^{-2} d^{-1} for the first and second weeks, respectively. (auth)

28183 (BNWL-434) FIXATION OF RADIOACTIVE RESIDUES. Research and Development Activities Quarterly Progress Report, January–March 1967. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

Approximately 800,000 Ci of radioactivity were processed in two pot solidification runs. Self-generating heat densities of 16.5 and 30 W/L in the calcine were achieved in a 12 in. and 8 in. pot respectively. Air was found to be more reliable as an atomizing gas than steam. An internal mix spray nozzle, properly controlled, was found to perform reliably on the spray calciner. The Cs leach rate of mortar prepared from glass melter condensate was reduced by a factor of 10 when powdered zeolite was added. Sorption by hydrous manganese oxide is being investigated from the standpoint of ion exchange. Adsorption of $^{137}Ce^{+}$ and the interferences of alkali metal cations with cesium adsorption lend support to this interpretation. Several nonmetallic and cermet materials were tested for materials of construction for waste melters. Haynes Lt-1, and Haynes Lt-LB cermets showed promise and will be investigated further. Other materials tested were silicon carbide, silicon nitride, zirconium deboride, titanium carbide, and molybdenum disilicide. (auth)

28184 (ORNL-P-3053) DISPOSAL OF HIGH LEVEL SOLIDIFIED WASTES IN SALT MINES. McClain, W. C.; Bradshaw, R. L.; Empson, F. M. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 22p. (CONF-670512-3). Dep. CFSTI.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria.

Project Salt Vault, an experiment demonstrating the disposal of high-level radioactive solid wastes in an inactive salt mine 1000 ft below ground, at Lyons, Kansas is described. The objectives of the experiment were: confirmation of the feasibility and safety of waste disposal in salt mines; demonstration of waste handling equipment and techniques; determination of the stability of salt under the influence of heat and radiation; and collection of information on creep and plastic flow of salt. Of the six experimental rooms in the mine, the main radioactive array contains seven 12 ft deep holes with electrical heaters and a canister with two ETR fuel assemblies for waste simulation. To note the effects of radioactivity, an identical array without the ETR fuel assemblies was constructed in another experimental room. Experimental data and conclusions are presented along with solutions to structural problems encountered in the experiment. The desirability of establishing an actual disposal facility is now being examined based on the results derived from Project Salt Vault. (D.C.C.)

28185 (ORNL-P-3054) HYDRAULIC FRACTURING AS A WASTE DISPOSAL METHOD. McClain, W. C. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 20p. (CONF-670512-4). Dep. CFSTI.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria.

A method is described for the subterranean disposal of radioactive waste. The method which is based on hydraulic fracturing consists of pumping a mixture of aqueous waste and cements into a nearly horizontal fracture located in a deep shale formation. After injection of the mixture, the cements serve as a confining seal for the radioactive waste. The most economic cement solution was found to consist of Portland cement (Type II), fly ash, attapulgite clay to prevent phase separation, illite (Grundite) to serve as retention of radiocesium, and a retarder (Delta Gluconolactone). Analysis of the stresses and deformations induced around the injected mixtures indicates that any failure of the rock barrier will cause a vertical fracture rather than an extended horizontal fracture. A method of calculating the maximum capacity of a fracture facility in terms of allowable stresses is presented. Data on cost analysis and evaluation procedures for possible sites are also presented. (D.C.C.)

28186 (PEL-143) THE PHILOSOPHY AND PRACTICE OF LIQUID RADIOACTIVE WASTE TREATMENT AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Barbour, R. A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jan. 1967. 18p. Dep.

The liquid radioactive waste treatment plant at Pelindaba on the Crocodile River in South Africa is described. The plant was designed to handle the following effluent volumes: active waste 1100 to 16,500 gal/24 hr; active waste 2200 gal/8 hr shift; and high-level waste 550 gal/8 hr shift. Methods of effluent decontamination including chemical treatment, ion exchange, and evaporation are described. Standards for discharging effluent into the Crocodile River are given. The rate of discharge of the river is such that the concentration of radionuclides does not exceed the maximum permissible concentration for water to be used as drinking water. (F.S.)

28187 INSURANCE PROBLEMS IN THE PREPARATION AND DELIVERY OF FUEL ELEMENTS. Ruppert, H. (Allgemeine Elektrizitaetgesellschaft–Telefunken, Frankfurt am Main). Atomwirtschaft, 12: 143-5(Mar. 1967). (In German).

Insurance problems in the preparation and delivery of fuel elements have different characteristics. In liability insurance this problem is essentially that fuel element plants are not atomic installations according to paragraph seven of the atomic law. A solution can be obtained by ratification of the Paris Liability Convention, by modification of the coverage regulations, or by rational interpretation of the law. In insurance cases problems arise from the coupling of nuclear energy risk with the fire insurance and with respect to the protection of the supplier against damage claims. (tr-auth)

28188 LEVELING AND ROTATING APPARATUS FOR SOLIDIFYING RADIOACTIVE LIQUID WASTE. Yoshinaga, Toshiaki (to Hitachi Ltd.). Japanese Patent 1966-11680. May 31, 1966. Filed July 24, 1963.

The apparatus proposed is for solidifying a radioactive liquid waste by mixing with cement. The support holding a can (in which a liquid waste and cement are to be placed for the solidification) is installed rotatable (for levelling the can) on the truck; the truck runs back and forth in the apparatus. The rotatable support is operated remotely by means of a gear attached to the support, and a rod with the operating handle, the threaded end of which engages with the support gear. Further the truck is provided with rollers for rotating the can when it is levelled (i.e., brought down); the length of array of the rollers can be adjusted according to the dimension of the can. (NSA of Japan)

Vacuum Engineering

Refer also to abstract 29349.

28189 METHOD FOR MEASUREMENT OF SMALLEST OIL COVERINGS IN VACUUM SYSTEMS. Dobrozemsky, R. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria); Huber, W. K.; Viehboeck, F. Z. Naturforsch., 22a: 549-53(Apr. 1967). (In German).

To get information on extremely small organic deposits in ultrahigh vacuum systems the sensitivity of most of the conventional methods for thickness measurements is not high enough. Tritium with a half-life of 12.3 yr and a mean β energy of 5.4 keV was chosen as a tracer isotope. A method is described for tritium-labeling diffusion pump oils with specific activities up to 100 mCi/g. Using the liquid scintillation counting technique deposits of below 10^{10} molecules/cm^2 can be detected. Results with this tritium-labeled pump fluid are given under different operating conditions in an all-metal ultrahigh vacuum system. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 27995, 28045, 28136, 28171, 28176, 28341, 28582, 29070, 29071, 29073, 29352, 29416, 29434, 29657, 29672, 29821, 29828, and 30276.

28190 (AECL–2680) THE AMPLIFIER-DISCRIMINATOR DESIGNED FOR THE NM-64 NEUTRON MONITOR. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 14p. (CRGP–1254). Dep. CFSTI. CAN $0.50.

The amplifier-discriminator designed for the large boron-trifluoride counters used in the NM-64 monitors is described, together with the testing procedures used by the factory. (auth)

28191 (AEEW-R–514) A FISSION COUNTER FOR THE MEASUREMENT OF NEUTRON CAPTURE TO FISSION RATIO IN ^{239}Pu. Allen, F. H. (Atomic Energy Establishment, Winfrith (England)). Mar. 1967. 14p. Dep.

By designing a fission counter with two electrode assemblies in one container it was possible to manufacture a counter containing 20 mg of ^{239}Pu. This required the use of a filling gas with a fast electron collection time, and a fast pulse channel amplifying system; a mixture of 85% argon and 15% methane at 100 lb/in.^{2} abs. was used. Good discrimination between alpha build-up pulses and fission pulses was achieved. (auth)

28192 (AERE-M–1850) ANGULAR PARAMETERS OF NEUTRON REACTIONS AS A MEASURE OF NEUTRON ENERGY. Silk, M. G. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 35p. Dep. CFSTI. UK 5s. 0d.

An investigation was made of the suitability of the parameter ϕ (the angle between the reaction products) as a measure of the neutron energy. The potential useful energy range of this technique was studied, and preliminary designs are considered for a neutron spectrometer which can be used for in-pile experiments. It is concluded that such a spectrometer should be satisfactory over an energy range from below 10 keV to 1 MeV, but that its effectiveness at low energies in thermal reactors may be limited by the fast-neutron events by thermal-neutron reactions due to Rutherford scattering of the reaction products. (auth)

28193 (AERE-R–5314) ANALYSIS OF FISSION AND WESTCOTT THERMAL NEUTRON FLUX MEASUREMENTS WITH NICKEL AND COBALT. Wade, B. O.; Bailey, E. A. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 65p. Dep. CFSTI. HMSO 9s. 0d.

The ^{58}Ni (n,p) ^{58}Co threshold reaction is frequently used for monitoring fast neutron doses in DIDO and PLUTO. As ^{58}Co has a high thermal neutron capture cross-section, the ^{59}Co (n,γ) ^{60}Co reaction is used to determine the thermal neutron flux, so that the appropriate correction can be applied. A method of analyzing the measured activities of pieces of nickel and cobalt wire to give fast and thermal neutron doses is described. The method assumes that the neutron fluxes are proportional to the reactor power, and corrections are included for the decay and burn-up of the isotopes involved. An approximation made in the reaction scheme for ^{58}Co gives a negligible error for thermal neutron fluxes up to 10^{15} n cm^{-2}s^{-1}. The data input to a STRETCH program which carries out the analysis is described. (auth)

28194 (AERE-R–5315) AFCA2: A COMPUTER PROGRAM FOR THE ANALYSIS OF DATA FROM AN AUTOMATIC FOIL COUNTER. Jones, E. D.; Baker, E. A. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 96p. Dep. CFSTI. UK 12s. 0d.

The Automatic Foil Counter is used for gamma-counting foils with activities up to 5μCi. Two sets of scintillation counters are incorporated, for gamma energies above and below 0.25 MeV. The irradiated detectors, of any reasonable geometric shape, are supported in trays which are loaded manually into the counter. Each load of trays will contain detectors, standard foils, and empty trays which act as backgrounds. The detectors are cycled past the scintillation counters and are counted automatically (in one of five possible modes of operation of the counter), and the results are punched on IBM cards. For analysis by the computer program AFCA2, any single load may contain detectors of more than one nuclide, different types of detectors for the same nuclide, and detectors from different irradiations, providing the counting conditions are similar. The limitations for each load are 120 trays, 10 counting cycles, 4 different types of detector, and 10 different irradiations. All the numerical information necessary for analysis is stored on magnetic tape. The data are divided into 15 blocks, each block containing all the data associated with one nuclide, with facilities for storage of up to 10 sets of calibration efficiency factors. The efficiency is determined by irradiating the detector in a uniform flux, followed by analysis with AFCA2 using a standard option. AFCA2 calculates the individual reaction rate of each detector, corresponding to its count rate, together with the error calculated from counting statistics and assumed errors on other variables. These quantities are averaged for each detector in each counter cycle and for all cycles, and are weighted according to the detector count rates. The mean reaction rates and errors on the mean reaction rates are thus determined. The determination of the thermal-flux parameters ϕ_θ, r, and T is included in AFCA2, and facility is available by small changes to the program for adding further calculations involving the detector reaction rates. The computer program AFCA2 is written in S2 Fortran for the STRETCH computer. The Fortran listing, and examples of input and output data, are given. (auth)

28195 (AERE-R–5412) CELFIT: A COMPUTER PROGRAM TO REFINE CRYSTAL UNIT CELL DIMENSIONS. Bracher, B. H. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1967. 30p. Dep. CFSTI. UK 4s. 0d.

A computer program, written in FORTRAN, for the refinement of the unit cell parameters of a crystal is described, including the method of refinement, and details of input formats. (auth)

28196 (AFWL-TR–67-39) CHARGE SENSITIVE PREAMPLIFIER USING FIELD-EFFECT TRANSISTORS. East, Larry V. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Apr. 25, 1967. 36p. CFSTI.

A general-purpose charge-sensitive Field-Effect Transistors (FET) preamplifier for use with high-resolution solid state radiation detectors is described. The germanium-equivalent noise linewidth of the preamplifier is less than 1.5 keV at room temperature when followed by an amplifier using single RC differentiation and integration time constants of 1 to 2 microseconds. The change in noise linewidth with input capacitance is ~0.07 keV/pf. When used with a 4 cm^2 × 0.5 cm lithium-drifted germanium detector, an energy resolution of 2.2 keV has been obtained for gamma-rays of 100 keV or less. The entire preamplifier may be operated below room temperature for improved noise performance. (auth)

28197 (BLG–405) FLUX DEPRESSION BY THERMAL NEUTRON DETECTORS. De Corte, L. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Dec. 1964. 24p. Dep.

The problem of flux depression in and around a thermal neutron detector is treated on the basis of the integral form of the stationary transport equation, which is approximately solved for symmetrical regions. For most detectors of interest, the results of this method are in good agreement with those obtained by solving the integral equation directly. (auth)

28198 (BMwF-FBK–67-17) MESSMETHODEN ZUR UNTERSUCHUNG SCHNELLER ABKLINGVORGAENGE. (Methods for Measuring Quickly Decaying Luminescence Processes). Schmillen, A. (Giessen Univ. (West Germany). Physikalisches Institut(I)). Mar. 1967. 23p. (In German). Dep.

Two methods used for measuring quickly decaying luminescence processes of scintillators and some results are discussed. The first method, the phase fluorometric determination of decay times, reaches a time resolution of some 10^{-11} sec. The second method, the direct oscillographic registration, gives more detailed information, but using commercial photomultipliers it has a smaller time resolution of about 10^{-9} sec. With a special image converter developed in our laboratory and briefly reported in the following paper the time resolution is improved by about a factor of ten. As an example measurements on the single crystal system Brasan/tetracene are discussed. (auth)

28199 (BMwF-FBK–67-18) RUECKSTREUUNG VON β-STRAHLEN AN SILIZIUM p-i-n HALBLEITERZAEHLERN. (Backscattering of β-Particles From Lithium-Ion-Drift Silicon Detectors). Huehn, E. A. (Giessen Univ. (West Germany)). Mar. 1967. 27p. (In German). Dep.

The response of Li-drifted Si detectors to monoenergetic β-particles from 200 to 1700 keV is studied. The low energy tail and the energy loss factor are determined from the measured spectra. The energy loss factor, varying from 17% at 200 keV to 40% at 1.7 MeV, is a linear function of primary β-particle energy. Besides the backscattering, another effect contributing to the low energy tail is possibly caused by ionization processes in the Si wafer of the counter. This effect becomes dominating with increasing β energy. The results are applied to correct the ^{204}Tl Curie plot. (B.G.D.)

28200 (BNL–977) SOFTWARE FOR A SPARK CHAMBER READER SYSTEM. Heller, S.; Malament, J.; Padwa, L.; Strongson, M. (Brookhaven National Lab., Upton, N. Y.). Mar. 1966. Contract AT-30-2-GEN-16. 28p. Dep. CFSTI.

A computer program is described by which straight line patterns of sparks in rectangular chambers are recognized given a magnetic tape of input data produced by an off-line flying spot digitizer. (B.G.D.)

28201 (BNL–8083(Suppl.1)) BUBBLE CHAMBERS BIBLIOGRAPHY. SUPPLEMENT I. Comstock, Marjorie (Brookhaven National Lab., Upton, N. Y.). May 1, 1967. 33p. Dep. CFSTI.

One hundred and eighty-eight references are presented on bubble chambers components and applications to supplement a previous bibliography dated May 28, 1964. The references are arranged in chronological order and an author index is included. (B.G.D.)

28202 (BNWL–395) ^{11}B BETA CURRENT THERMAL NEUTRON FLUX DETECTOR. Jackson, C. N. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 30p. Dep. CFSTI.

The design and performance of a ^{11}B beta current in-core neutron flux detector was investigated during a thermal neutron detector development program. Experimental results, beta current calculations, and some results obtained with a ^{103}Rh self-powered detector are given. Test instrumentation and in-core capsule design are described. (auth)

28203 (CERN–67-10) UZU: A PROGRAM WHICH SIMULATES BUBBLE CHAMBER TRACKS. Yoshiki, H. (European Organization for Nuclear Research, Geneva (Switzerland)). Apr. 13, 1967. 92p. Dep.

The program UZU (meaning "vortex" in Japanese) monitors the geometrical reconstruction programs in the bubble chamber analysis by producing simulated tracks with given initial parameters. It can be applied to any bubble chamber equipped with a homogenous magnetic field, a parallel plate window, and three cameras whose optical axes are perpendicular to it. By means of control cards, it can simulate the tracks of pure helix, with measurement errors, with single or multiple scattering, with ionization loss, with bremsstrahlung, or any other combinations of these. It can test the reconstruction programs in various ways, such as mathematical correctness of the program, the mean values by the reconstruction program, their variances, the adequateness of various criteria (for the scanning or the measurement), and of corrections. The operation and application of UZU are presented. (auth)

28204 (CISE–107) OPTIMIZATION OF THE SIGNAL-TO-NOISE RATIO IN PRESENCE OF NOISE AND PILE-UP FLUCTUATIONS. Bussolati, C.; De Lotto, I.; Gatti, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). Mar. 1967. 34p. (CONF-670520–1). Dep.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

The optimization of the signal-to-noise ratio in presence of noise and pile-up fluctuations is examined. A general analysis of the optimum weights for a weighted linear combination of two or three samplings on the input pulse is presented. Some cases of particular interest are then analyzed to evaluate the efficiency of the proposed method of amplitude measurement. (auth)

28205 (DESY–67/10) MAGNETIC SPECTROMETER FOR HIGH-ENERGY ELECTRON SCATTERING EXPERIMENTS. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J. M.; Meyer-Berkhout, U.; Morrison, R. J.; Nguyen-Ngoc, H.; Schmidt, W.; Steffen, K. G.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1967. 20p. Dep.

A spectrometer composed of deflecting magnets and magnetic quadrupoles is described which is designed to analyze particles scattered in the angular range 8 to 35° and at incident energies up to 6 GeV. A momentum discrimination between 0.2 and 0.7%, depending on the scattering angle, was achieved. The performance of the spectrometer for the scattering of 5.275-GeV electrons from protons at 12.5° is described. (auth)

28206 (EGG–1183-2134) ACCOMPLISHMENTS OF THE X-RAY DETECTOR PROGRAM THROUGH FY67. Technical Report No. S-373-R. Anderson, George C. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Apr. 17, 1967. Contract W-7405-eng-48. 90p. (UCRL–13297). Dep. CFSTI.

For Univ. of California Lawrence Radiation Lab., Livermore.

Theoretical and experimental studies leading to the design and construction of an x-ray detector for measuring x rays in the energy region of 20 to 200 keV are summarized, and the detector's performance is evaluated. The detector, which operates on the photoelectric effect, uses four independent emitter plates to produce four simultaneous output signals. It has a response time of 0.8 nsec (FWHM) and a rise time of 0.01 nsec, making it suitable for detecting transient x-ray pulses. Used in conjunction with an iterative matrix technique, the detector's multichannel output also permits reconstruction of transient x-ray or bremsstrahlung spectra. (auth)

28207 (JAERI–1131) FABRICATION OF THICK GERMANIUM DETECTORS. Ishii, Mitsuhiko; Tamura, Tsutomu; Shikazono, Naomota; Takekoshi, Hidekuni (Japan Atomic Energy Research Inst., Tokyo). Nov. 1966. 12p. Dep.

Lithium-drifted germanium detectors of depletion depths up to 8 mm and diameter about 19 mm were fabricated from pulled, indium-doped, p-type single crystals. The detectors have an energy resolution of 4–5 keV (FWHM) for gamma rays from ^{60}Co, when used with a conventional low-noise preamplifier. The procedure for fabricating the thick germanium detectors is described in detail. (auth)

28208 (LYCEN–6716) CONTRIBUTION A L'AMELIORATION DES MESURES NUCLEAIRES PAR TRAITEMENT DE L'INFORMATION. (Contribution to the Improvement of Nuclear Measurements Through Data Processing). Escudie, Bernard (Lyon Univ. (France). Institut de Physique Nucleaire). Mar. 1967. 161p. (In French). Dep.

Thesis.

A study was made to reduce the perturbing influence of the background either by optimum filtering or by correlation. A subsequent study was then made to increase resolution in nuclear measurements. This lead to the study of a device capable of separating the ideal constituents of interfering signals frequently found in nuclear spectrometry. The experimental data showed that the statistical fluctuations and the parasitic signals due to radioactive sources that could not be eliminated strongly perturbed the nuclear spectra observed. This lead to the suggestion of numerically filtering the perturbed signals or peaks by their adapted filters. The gain in precision is of the order of 10 or more. In the case of an identification experiment of particles by the ionization method, the detection of the presence and extraction by correlation was used. The filtering used made it possible to detect events with invariant performance as a function of the power of the background of the detecting junctions, which vary slowly with time. The statistical properties of the signals and the background make it possible to improve the signal-to-noise ratio by correlation. The estimation of the parasitic terms makes it possible to obtain the identification function with a precision at least equal to that obtained by filtering the signals E and $\Delta E/\Delta X$. In the study of the improvement of the resolution capacity, an attempt was made to find an aspect of the original signal which the measurement device has strongly perturbed. The measurement makes in effect a separation of the observed phenomena. The resolution of the filtering equation is called deconvolution. Among the various methods of possible deconvolutions, a procedure using a calibrated electric simulation was studied. This procedure approximates the inverse filter of the linear measurement filter. The gain in resolution is of the order of 5 to 10. The application to nuclear measurement is divided into two groups according to whether the signal studied is continuous or pulsed. (J.S.R.)

28209 (NORA-Memo–123) ON THE USE OF SOLID STATE NUCLEAR TRACK DETECTORS IN REACTOR PHYSICS EXPERIMENTS. Tuyn, J. W. N. (Institutt for Atomenergi, Kjeller (Norway)). Mar. 1966. 17p. Dep.

Some methods to replace counting of tracks, produced by fission fragments and α-particles in several detector materials are discussed. Results of preliminary measurements of fast neutron flux distributions are presented. (auth)

28210 (ORNL-P-3064) LOW-NOISE WIDE-BAND CURRENT PREAMPLFIER FOR USE WITH SEMICONDUCTOR DETECTORS. Millard, J. K.; Blalock, T. V. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 6p. (CONF-670520–2). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

A new low-noise wide-band current preamplifier was developed for use in fast-signal processing systems for semiconductor detectors (such as systems where gating operations are performed on amplified current pulses from a detector). This preamplifier consists of a single current-gain section with paralleled field-effect transistors in the input stage. The equivalent noise current of the preamplifier is about an order of magnitude below that of previously reported current preamplifiers of comparable bandwidth. The gain-bandwidth product of the preamplifier is 25 GHz. (auth)

28211 (ORO–2504-105) FIDCON. Technical Report No. 679. Wolsky, Gilbert (Maryland Univ., College Park. Dept. of Phys-

ics and Astronomy). Apr. 1967. Contract AT(40-1)-2504. 28p. Dep. CFSTI.

A program (FIDCON) is described which is used to generate sets of optical parameters for use by the geometrical reconstruction programs such as PANG and TVGP. FIDCON is an outgrowth of 1-2-3 POP. Input to the program consists of measurements of fiducials and possibly of corresponding points. The corresponding points are treated as pseudo-fiducials. For each measurement two fits are attempted, an 8 parameter and a 10 parameter fit. Derivations are given for many of the equations used. The program, measuring procedure, and running instructions are described in detail. Results for the BNL 80" hydrogen bubble chamber are also given. (auth)

28212 (RHEL-R-140) FATIGUE TESTS ON PRESSURISED MEMBRANES OF POLYETHYLENE TEREPHTHALATE. Middleton, A. J. (Rutherford High Energy Lab., Chilton (England)). Feb. 1967. 14p. Dep. CFSTI. UK 2s. 6d.

Fatigue of flexible thin windows for high-energy physics apparatus is investigated. The number of load reversals that can be sustained before failure is determined and a practical limit recommended. (auth)

28213 (UCRL-17063) APPLICATION OF THE STARS PRODUCED IN A NUCLEAR EMULSION TO THE DETERMINATION OF A HIGH NEUTRON ENERGY SPECTRUM. Omberg, Ronald P.; Patterson, H. Wade (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1967. Contract W-7405-eng-48. 30p. Dep. CFSTI.

A method is presented for determining the relative shape of a high-energy neutron spectrum by utilizing the gray prongs produced in a nuclear emulsion. The method consists of assuming a flux shape that contains a single arbitrary parameter; this parameter is then determined by requiring the calculated number of gray prongs per star to agree with the value measured in the emulsion. The advantage of this method is that its accuracy is relatively independent of the magnitude of the energy range considered; this is because the product of the flux and the star production rate, if the cross section is assumed to be independent of energy, is relatively constant over a large energy range for fluxes that vary approximately as 1/E. (auth)

28214 (UCRL-17220) ON-LINE REAL-TIME OPERATION OF A PDP-7 DATA-TAKING SYSTEM. Robinson, Lloyd B.; Meng, J. D. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 16, 1967. Contract W-7405-eng-48. 11p. (CONF-661114-2). Dep. CFSTI.

From Digital Equipment Computer User's Society Meeting, Berkeley, Calif.

Hardware and software developments which permit simultaneous use of a PDP-7 computer for both data-taking and preliminary data analysis are described. The hardware includes a set of remote-control consoles, and a memory-protection system. System programming is not yet complete, but currently operating programs allow concurrent data-taking from as many as four remote stations, with versatile CRT display, graph plotting, storage on both IBM-compatible and micromagnetic tape, and printout on an electric typewriter. A third-order polynomial background-fitting routine was also written, mainly as a demonstration of the capabilities of the system, since most data analysis should be carried out with the CDC-6600 facility at the main computer center. Work was also done to simplify the preparation of future machine-language programs for the PDP-7. (auth)

28215 (UCRL-17328) REMARKS ON THE USE OF THE SPIRAL READER. Lynch, Gerald R. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 5, 1967. Contract W-7405-eng-48. 22p. (CONF-661208-4). Dep. CFSTI.

From American Physical Society Meeting, Nashville, Tenn.

The performance of the Spiral Reader measuring machine is discussed and the device is compared with other machines that measure bubble chamber film. The methods used to filter out tracks from the measured data are described. (auth)

28216 (UCRL-17505) HIGH-SENSITIVITY NEUTRON AND PROTON FLUX DETECTOR WITH A PRACTICAL THRESHOLD NEAR 600 MeV, USING Hg (SPALLATION) ^{149}Tb. McCaslin, Joseph B.; Stephens, Lloyd D. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 14, 1967. Contract W-7405-eng-48. 28p. (CONF-670610-2). Dep. CFSTI.

From 12th Annual Meeting of the Health Physics Society, Washington, D. C.

Correct evaluation of radiation exposures received by individuals working near high-energy accelerators depends upon measurement of the radiation field involved. The measurements of the separate components and the determination of their energy spectrum are basic to this evaluation. No single instrument or detector can make these measurements; therefore, a variety of detectors must be employed. A detector is described for the measurement of high-energy particles which utilizes the spallation of mercury to ^{149}Tb, an alpha emitter with a 4.12-h half-life. This reaction has a threshold between 500 and 600 MeV, and extends the use of threshold detectors into another energy decade. The Hg → ^{149}Tb reaction has been successfully used to measure relative neutron production from targets as a function of angle for energies up to 26 GeV. (auth)

28217 (AD-645794, pp 5-17) MULTICHANNEL PHOTOMULTIPLIERS FOR THE REGISTRATION OF X-RAY RADIATION. Andreeva, L. I.; Stepanov, B. M. Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1959.

Electron optics and features of multichannel photomultipliers are considered. Multichannel photomultipliers which were developed for registration of x radiation with broadband output have a maximum output current of 7 A depending upon input conditions and a resolving time of 2.5×10^{-9} sec. (auth)

28218 (ORNL-tr-1651) GAMMA SPECTROMETRY BASED ON GERMANIUM DETECTORS. Maslova, L. V.; Matveev, O. A.; Ryvkin, S. M.; Strokan, N. B.; Khusainov, A. Kh. Translated by Martha Gerrard and P. S. Baker (Oak Ridge National Lab., Tenn.), from paper presented at the IAEA Panel Meeting on Lithium-Drifted Germanium Detectors, Vienna, June 6–10, 1966. 6p. (CONF-660625-4). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The preparation of electrical contacts on Ge(Li) detectors is discussed. These contacts must be made very carefully in order to obtain high resolution and minimum detector noise. A method for fabrication of germanium detectors is described. It is based on introduction of radiation defects in a germanium crystal. The advantage of these detectors compared with Ge(Li) detectors is the fact that they do not have to be stored at liquid-nitrogen temperatures. The characteristics of these radiation detectors are preserved during storage at room temperature. (auth)

28219 DOUBLE-FOCUSING MAGNETIC PAIR SPECTROMETER. Balzer, R.; Bharucha, D.; Heinrich, F.; Hofmann, A. (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 197-216(1967). (In German).

By use of a double-focusing magnetic field of the form $H = H_0 a/r \sin \Theta$, the properties, especially the response function and the spectral sensitivity, of a γ pair spectrometer were calculated. Since up to resolutions of 0.1% the transmission of 1.8% remains constant, a good sensitivity of the instrument at higher resolutions results. The theoretical predictions were confirmed by measurements at 17.7 MeV and show that the 1/r spectrometers are much superior to the classical magnetic pair spectrometer. (tr-auth)

28220 BUBBLE CHAMBER MEASUREMENTS AND THEIR EVALUATION. Soop, Karl (CERN, Geneva). pp 217-328 of Progress in Nuclear Techniques and Instrumentation. Vol. 2. Farley, F. J. M. (ed.). New York, John Wiley and Sons, Inc., 1967.

A detailed treatment is given of the various stages in the processing of bubble chamber data. An attempt is made to correlate different methods in the general pattern of data evaluation. The processing falls into three stages: measurements; geometrical and kinematical analysis of events, one at a time; and analysis performed on samples of events. The discussion deals mainly with these stages, but as subsidiary topics consideration is given to event formation and photography, labeling and recording of events, and book-keeping, updating, and display of results. Mechanical and program-technical descriptions are avoided, the stress being on the logics of data transformation. A catalog of frequently used symbols is also included. 158 references. (L.B.S.)

28221 LIQUID SCINTILLATION COUNTING OF TRITIATED COMPOUNDS SUPPORTED BY SOLID FILTERS. Gill, D. M. (Cambridge Univ., Eng.). Int. J. Appl. Radiat. Isotop., 18: 393-8(1967).

When a tritiated compound is adsorbed by a solid filter and counted in a liquid scintillation spectrometer, the efficiency with which it is counted is very dependent on the nature of the support. Glass fibre paper allows efficiencies of about 10% and is the most useful supporting material for most compounds. Standard cellulose chromatography papers allow efficiencies of between 2% and 8%, depending mainly on the size of the tritiated molecules, while modified cellulose papers allow only lower efficiencies. Penetration of the tritiated material into amorphous regions of the cellulose fibres appears to be responsible for these differences. (auth)

28222 NUMERICAL METHOD FOR ANALYZING GAMMA SPECTRA. Flandre, J. P. (Institut Royal Meteorologique, Brussels). Int. J. Appl. Radiat. Isotop., 18: 337-43(1967). (In French).

A gamma spectrometer can be represented by means of a matrix. The construction of such a matrix (100 × 50) by using a few radioactive sources of monochromatic gamma rays is described. The application of this method, to activation analysis and the diffusion of gamma rays through shielding is considered. The accuracy reached is greater than by graphical methods. (auth)

28223 FABRICATION OF HIGH QUALITY SILICON JUNCTION DETECTORS BY LOW ENERGY ION IMPLANTATION. Kalbitzer, S. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Bader, R.; Herzer, H.; Bethge, K. Z. Phys., 203: 117-18(1967).

High quality silicon junction detectors were made by implantation of boron and phosphorus ions into silicon wafers. Resolutions of 20 keV for Po α-particles were obtained. (auth)

28224 THE CALCULATED CALIBRATION OF A QUANTAMETER FILLED WITH Ar + CO_2 MIXTURE. Tomimasu, T. (Electrotechnical Lab., Tokyo). Nucl. Instrum. Methods, 52: 341-2(1967).

The energy dependence of the mean mass stopping power ratio of copper to argon for high energy photons was studied theoretically. The calculated stopping power ratio for bremsstrahlung beams changes by 7% in the energy region 0.1 MeV to 1000 MeV. The calculated calibration of the quantameter filled with Ar + CO_2(20°C, 800 Torr) mixture is compared with recent experimental data. The calculated calibration is in good agreement with experimental ones in the whole energy region, however, the systematic discrepancy of 3% is found between them. (auth)

28225 REDUCING CHARGE-SENSITIVE-AMPLIFIER SENSITIVITY TO DETECTOR CAPACITANCE VARIATIONS. Goldsworthy, W. W. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 52: 343-4(1967). (UCRL-17403).

A method for reducing the sensitivity of charge-sensitive preamplifiers to detector capacitance variations is described. This method is directly applicable to many existing charge-sensitive preamplifiers with only minor modifications. (auth)

28226 PRECISION IN SPARK LOCALIZATION IN MAGNETOSTRICTION SPARK CHAMBERS. Giannelli, G.; Marangelli, B.; Ricco, M. (Univ. of Bari, Italy. INFN, Bari, Italy. GIFCO, Bari, Italy). Nucl. Instrum. Methods, 52: 345-6(1967).

The precision obtainable in the spark localization in magnetostrictive wire spark chambers is discussed. The measurements on the propagation of pulses in magnetostrictive wires previously published are elaborated and it is shown that in these experiments the spark position was determined with a precision of ±0.1 mm. (auth)

28227 A CONSTANT ACCELERATION MOESSBAUER SPECTROMETER UTILIZING A MULTICHANNEL ANALYZER MODIFIED FOR FORWARD-BACKWARD ADDRESS SCALING. Reggev, Y.; Bukshpan, S.; Pasternak, M.; Segal, D. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Instrum. Methods, 52: 193-6(1967). (IA-1118).

The constant acceleration drive system devised utilizes the triangular waveform of the address scaler of a multichannel analyzer which is modified for forward-backward address scaling. Thus automatic folding of the spectrum is attained, and the channel capacity of the multichannel analyzer is exploited with 100% efficiency. (auth)

28228 VIDICON SYSTEM FOR SPARK CHAMBERS. Crawford, J. F.; Dobinson, R. W.; Osmon, P. E.; Strong, J. A. (London Univ.). Nucl. Instrum. Methods, 52: 213-21(1967).

In order to cut down the time required to scan and measure spark chamber systems an automatic system was developed. The system uses vidicon cameras and can digitize and record the positions of up to 4 sparks per gap. Scanning accuracy is 0.1% of full scan. During a beam pulse from a large particle accelerator up to 5 events can be recorded in a core store. During intervals between beam pulses the core store is read out on to I.C.T. compatible magnetic tape. (auth)

28229 MONITOR FOR 4 TO 8 MeV NEUTRONS SUITABLE FOR (n,p) AND (n,α) EXPERIMENTS. Durisch, J. E.; Foroughi, F.; Rossel, J. (Univ., Neuchatel, Switzerland). Nucl. Instrum. Methods, 52: 222-8(1967).

A monitor counter for fast neutrons is described based on recoil protons emitted from a thin 60 μm polyethylene radiator within a small solid angle and detected by a silicon surface barrier detector. It is capable to select the incident neutrons by their energy as well as by their direction. The absolute neutron flux is measured with a precision of 4% and its relative fluctuation over several days is better than 1%. The electronic equipment required is simple because of its quite unsensitive threshold setting. The relationship D = const. $(V\rho)^{\frac{1}{2}}$ between the depth D of the depletion layer of a silicon surface barrier detector and the applied bias V was checked by counting the alphas of the $^{29}Si(n,\alpha_0)^{26}Mg$ reaction produced by a fixed number of 6 MeV incident neutrons within the depletion layer of the silicon diode for a set of eight values of D; this relationship was found to be confirmed. Also agreement was found between the measured cross section of the $^{29}Si(n,\alpha_0)^{26}Mg$ by Anderson and our value $\sigma = 30 \pm 4$ mb for $E_n = 6$ MeV. As an appendix the energy loss ΔE_x was computed for a charged particle x of incident energy E_x passing through the depletion layer of a silicon surface barrier detector having a thickness D (in μm). The computations were done for protons, deuterons, tritons, ^{3}He and alphas for a set of 15 different thicknesses D in the interval between 50 and 1000 μm and for 20 values of the energy of the incident particle x changing from 2 to 20 MeV. (auth)

28230 CHARGED PARTICLE MASS IDENTIFICATION. Emerson, S. T.; Simpson, W. Dwain; Legg, J. C.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Instrum. Methods, 52: 229-37(1967). (ORO-1316-23).

A time-of-flight particle identification technique was developed and applied for charged particles in the range from mass 1 to mass 9, and from 0.5 MeV to 10 MeV. The technique has the advantage of wide dynamic range and also affords a significant reduction in the background of random coincidences. (auth)

28231 BEAM PROFILE SCINTILLATION COUNTER HODOSCOPE. Lehraus, I. (CERN, Geneva). Nucl. Instrum. Methods, 52: 238-40(1967).

A scintillation counter hodoscope, constructed from three stacks of plastic scintillator strips and a system of plexiglass light pipes leading to ten photomultipliers, is described. A remotely operated mechanical shutter allows for selection of the scintillators for measurement of high-energy particle beam profiles in the vertical plane with resolution 2 mm or 5 mm per channel, and in the horizontal plane with resolution 5 mm per channel. The individual responses of all channels were adjusted to be equal within 5% limits and, in the fast ejected beam (spill time 10 ns to 0.6 μs), a set of gated integrators with digital output was used. For longer beam spill time a set of 10 Mc/s gated discriminators triggered by the total flux monitoring counters was employed. (auth)

28232 PARALLEL PROCESSING PATTERN RECOGNITION SYSTEM UCPR1. Duff, M. J. B.; Jones, B. M.; Townsend, L. J. (London Univ.). Nucl. Instrum. Methods, 52: 284-8(1967).

The design of and philosophy behind a parallel pattern recognition system now being constructed at University College London are described. Performance of a simulation program is encouraging, but complete testing of the system requires that it shall be constructed. (auth)

28233 ELECTRON-GAMMA AND ELECTRON-ELECTRON COINCIDENCE SPECTROMETERS WITH SEMICONDUCTOR COUNTERS. Bosch, H. E.; Szichman, E.; Baseggio, A.; Dolinkue, R. (IIAE-DINFIA, Buenos Aires). Nucl. Instrum. Methods, 52: 289-92(1967).

A special vacuum chamber containing a lithium drifted silicon detector and the radioactive source was designed for electron-gamma coincidences. The gamma rays were detected outside it with conventional scintillation counters. A further modification of this chamber was done placing into it a second silicon detector in front of the former, thus obtaining an electron-electron coincidence spectrometer. Conversion coefficients corresponding to the transitions of 0.161 MeV and 0.0795 MeV in ^{133}Cs were determined. An additional measurement of the conversion coefficient corresponding to the 0.279-MeV transition in ^{203}Tl was performed by means of beta continuum-electron conversion coincidences. The values obtained are: $\alpha_K(0.161) = 0.18 \pm 0.03$ (K/LM = 5.2 ± 0.8); $\alpha_K(0.0795) = 1.8 \pm 0.4$ (K/LM = 5.5 ± 1.4); $\alpha_K(0.279) = 0.14 \pm 0.03$ (K/LM = 2.4 ± 0.3). (auth)

28234 MEASUREMENT OF THE DECAY TIMES OF ORGANIC SCINTILLATORS. Kirkbride, J.; Yates, E. C.; Crandall, D. G. (Edgerton, Germeshausen and Grier, Inc., Goleta, Calif.). Nucl. Instrum. Methods, 52: 293-7(1967).

A high-speed version of the monophoton technique is described for measuring the scintillation light decay as a function of time for organic scintillators. Experimental results are given for a wide range of commercially available scintillators. (auth)

28235 THE USE OF A SONIC SPARK CHAMBER WITH A 180° DOUBLE FOCUSSING MAGNETIC SPECTROMETER. Hardacre, A. G. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 52: 309-17(1967).

An account is given of the use of a thin foil one-dimensional sonic spark chamber as a focal plane detector for a double focussing magnetic spectrometer. Using a continuous flow filling of argon-ethanol and 0.0025 cm aluminum electrodes with a separation of 0.86 cm spatial resolutions of 0.9 mm fwhm have been attained with particles in oblique incidence, at angles of 57° to

the electric field. The chamber is used in coincidence with a double scintillator telescope, enabling particle identification and selection to be performed before triggering, on the basis of range estimation in a set of variable absorbers before the scintillators. The resulting backgrounds, with a time resolution of 1.2 μs, are negligible. The system operates reliably at 50 c/s at efficiencies differing from 100% by less than 1 part in 10^4, along the whole length of the focal plane. Line spectra, with good mass resolution, were obtained for charge-one particles resulting from reactions induced by 30 MeV protons. Overall energy resolutions of 60 keV were attained for these particles. (auth)

28236 A FAST NEUTRON SPECTROMETRIC TECHNIQUE. II. Koebler, D. R.; Grissom, J. T. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 52: 318-20 (1967).

A neutron spectrometer system has been constructed employing a stilbene crystal, a gamma discrimination circuit, and a multichannel analyzer. The spectrometric technique depends on the analysis of the light spectrum from the crystal and results have been obtained with neutrons from the D(d,n) and T(d,n) reactions. The resolution of the spectrometer system is determined by the energy resolution of the scintillator-photomultiplier subsystem and at 14 MeV is equivalent to that of a time-of-flight system of approximately 2-ns pulse width and a 1 m flight path. (auth)

28237 NEW TECHNIQUE FOR MEASURING WEAK NEUTRON SCATTERING IN LOW ENERGY RESONANCES. King, T. J.; Fullwood, R. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Instrum. Methods, 52: 321-4(1967). (TID-23192).

A new technique for measuring low energy neutron scattering was developed. This method incorporates a ^{6}Li glass detector plus a large liquid scintillator anti-coincidence mantle and provides high neutron efficiency, fast timing for time-of-flight spectrometry, and an extremely good discrimination against background in the glass due to neutron capture. This technique was tested by measuring scattering in the first seven resonances of tungsten. (auth)

28238 ESCAPE PROBABILITY OF MONOENERGETIC ELECTRONS FROM A THIN FOIL. Yamashita, M.; Michikawa, T. (Electrotechnical Lab., Tokyo). Nucl. Instrum. Methods, 52: 347-8(1967).

The escape probability of monoenergetic electrons from a thin foil was calculated on the basis of an experimental formula for the absorption curves. The calculation was extended to the case of β-rays of ^{198}Au in gold foils and the results were compared with the observed β-counting efficiency of activated gold foils. (auth)

28239 THE ENERGY OF THE ^{40}K GAMMA RAY AND ITS USE AS A CALIBRATION STANDARD. King, J. D.; Neff, N.; Taylor, H. W. (Univ. of Toronto). Nucl. Instrum. Methods, 52: 349-50 (1967).

The energy of the ^{40}K gamma ray was re-measured in order to increase its usefulness as a calibration line for Ge(Li) spectrometers. The observed value, 1460.75 ± 0.06 keV has an uncertainty which is improved by better than an order of magnitude over previous determinations. In addition the energies of two gamma rays emitted by natural-occurring thorium were determined with improved precision: the 727.1 ± 0.1 keV gamma ray emitted by ^{212}Bi and the 911.07 ± 0.07 keV gamma ray emitted by ^{228}Ac. (auth)

28240 SOME THEORETICAL RESULTS ON TIMING CHARACTERISTICS OF Ge(Li) DETECTORS. Balland, J. C.; Pigneret, J.; Samueli, J. J. (Institut de Physique Nucleaire, Lyon). Nucl. Instrum. Methods, 52: 351-3(1967).

The pulse shape resulting from the interaction of a gamma-ray with a thin Ge(Li) planar detector is calculated. It is found to depend on one random variable. By means of a suitable transformation, the distribution of the time at which the signal crosses a threshold is obtained. Some curves are presented. (auth)

28241 GEOMETRICAL EFFICIENCY OF A PARALLEL-DISC SOURCE AND DETECTOR SYSTEM. Ruffle, M. P. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 52: 354-6(1967).

The average solid angle subtended by a disc from points on a parallel, coaxial disc is expressed in terms of standard elliptic integrals. (auth)

28242 ON THE PARTICLE COUNTING ANALYSIS OF A PERSPEX CHERENKOV COUNTER. Mahesh, Krishan (Kurukshetra Univ., India); Srivastava, B. N. Nucl. Instrum. Methods, 52: 241-4(1967).

Some particle counting analysis of a perspex Cherenkov counter has been made, using cosmic ray particles as source of producing the Cherenkov radiation in a perspex medium. The extrapolated zero bias counting rate of the counter under different optical conditions is compared with the estimate as obtained by using the standard value of the cosmic ray flux for this counter geometry. This allows some conclusions to be made concerning the detection behavior of the counter. Observations of the counting rate of a reflecting type Cherenkov counter give, qualitatively, an idea of Cherenkov radiation losses in a perspex medium. (auth)

28243 LEAST-SQUARES ANALYSIS OF TIME-DEPENDENT GAMMA-RAY PULSE-HEIGHT SPECTRA. Yamamoto, S. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 52: 245-9(1967).

A computer method is described for estimating radionuclide abundances in a mixture by least squares analysis of a time-dependent set of gamma-ray pulse-height spectra. The pulse-height distributions and decay constants of the constituent radionuclides are used as known input information. The method was programmed for the computer and the program was tested by analyzing spectra of mixtures of ^{103}Ru and ^{106}Ru of known compositions, whose ^{103}Ru fractions varied from 10% to 90%. The mixture compositions were determined by this program with an accuracy of better than 2% of the actual amount, and in most cases better than 1%. (auth)

28244 MONITOR FOR SELECTED GAMMA MEASUREMENTS IN MILK. Bukowiecki, B. (Central Lab. for Radiological Protection, Warsaw). pp 109-12 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26-30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

A modified γ scintillation spectrometer was designed for use in monitoring milk samples. The monitor is a fully transistorized three-channel analyser which permits simultaneous measurement of three selected radionuclides. The three channels of the instrument contain three pairs of stable, low level discriminators fed by a photomultiplier through the emitter follower and phase converter. The pulses are registered in every channel by decatron counting tubes and mechanical scaler. The instrument can be powered by battery or electrical supply. (auth)

28245 ENERGY DEPENDENCIES OF THE LIGHT OUTPUT OF SOME ORGANIC SCINTILLATORS UNDER THE INFLUENCE OF α-PARTICLES. Tsirlin, Yu. A.; Sokolovskaya, T. I.; Nikulina, R. A.; Nagornaya, L. L.; Spendiarov, N. N. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 522-5(Apr. 1967). (In Russian).

Energy dependencies are investigated of the light output of some plastic scintillators and anthracene and stilbene crystals under the influence of α-particles by the energy of 1 to 5.15 MeV. It is shown that their specific scintillation efficiency equally changes with specific energy losses for organic crystals and some plastics. (auth)

28246 OPTICAL PROPERTIES OF THE NEW SCINTILLATION SINGLE CRYSTAL: NATRIUM-ACTIVATED CESIUM IODIDE. Panova, A. N.; Shakhova, K. V.; Shiran, N. V. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 549-50(Apr. 1967). (In Russian).

Some optical characteristics of the new scintillation single crystal—sodium activated cesium iodide—have been measured. This crystal has been shown to be a scintillator of high efficiency. The spectral composition of its luminescence with the maximum of 415 mμ and with a half-width of 105 mμ does not depend on the activator concentration and a type of excitation (photo or β-particles). CsI (Na) luminescence is assumed to be connected with annihilation of excitons localized at sodium ions in the iodine cesium lattice. (auth)

28247 COINCIDENCE SPECTROMETER WITH A PROPORTIONAL COUNTER. Grigor'ev, O. I.; Shimanskaya, N. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 459-65(Mar. 1966). (In Russian).

A description is given of a proportional counter connected in a coincidence circuit with a NaI(Tl) scintillation spectrometer designed for measuring L fluorescence yields, L to K capture ratios and for carrying out experiments in general that are based on the detection of soft radiations (E < 100 keV). The efficiency and resolution of the counter are discussed. Results of measurement of the L fluorescence yield of xenon are given. (L.B.S.)

28248 SECTOR-TYPE MAGNETIC SPECTROGRAPH FOR INVESTIGATING THE ENERGY AND ANGULAR DISTRIBUTIONS OF NUCLEAR REACTION PRODUCTS. Antropov, A. E.; Zarubin, P. P.; Orlov, B. N.; Plavko, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 466-8(Mar. 1966). (In Russian).

A brief description is given of the design and characteristics of the sector type magnetic spectrograph recently constructed at Leningrad State University; the spectrograph features circular boundary pole pieces of the Bainbridge–Backner type. (L.B.S.)

28249 EFFECT OF SPACE CHARGE IN PROPORTIONAL COUNTERS. PART I. Viktorov, S. V.; Kocharov, G. E. (Ioffe

Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 469-71(Mar. 1966). (In Russian).

A mathematical treatment is presented of the effect of space charge on the size of the output pulse of a proportional counter. A formula is derived which shows that the effect decreases the size of the output pulse by a factor of η, which is dependent on the direction of motion of the ionizing particle relative to the central wire. (L.B.S.)

28250 SOME STRANGE CHARACTERISTICS OF BF_3 PROPORTIONAL COUNTER. Miyashita, Kyoichi; Takada, Mamoru (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Giho, 7: 221-32(Oct. 1966).

In the case of a measurement of neutron flux using a BF_3 proportional counter, the temperature coefficient was found to be −1 to −2% for 30°C to 40°C change. Moreover the time lag of counting rate for initial application of voltage was studied. It was found that both phenomena are a kind of end effect. Hence, these are easily removed by shielding the ends of the tube. (NSA of Japan)

28251 OXIDE-PASSIVATED SILICON p–n JUNCTION NUCLEAR PARTICLE DETECTORS. Fujibayashi, Keiji; Miyashita, Kyoichi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Giho, 7: 203-20(Oct. 1966).

Oxide-passivated silicon planar-type nuclear particle detectors were fabricated and tested. The best energy resolution obtained with alpha particles of ^{210}Po (5.3 MeV) was 18 keV fwhm at room temperature. Detectors with the energy resolution of less than 30 keV fwhm were produced commercially without particular difficulties. Oxide passivation reduces the leakage current 10 to 100 times as much as ordinary p-n junction detectors and keeps the detectors very stable for long term operation. (NSA of Japan)

28252 PROPERTIES OF α-SCINTILLATION COUNTERS FOR RADIOMETRIC AND DOSIMETRIC INSTRUMENTS. Gorbushina, L. V.; Tyminskii, V. G. (Moscow Geological-Prospecting Inst.). Izv. Vyssh. Ucheb. Zaved. Geol. Razved., No. 9, 119-22(1966). (In Russian).

The counting efficiencies of some standard phosphors based on ZnS(Ag) in suspension in dichloroethane were studied. Their use in radiometers and dosimeters for alpha detection is discussed. (L.B.S.)

28253 POSSIBILITIES OF THE DETECTION OF LOW BETA-SOURCES CONCENTRATIONS IN WATER BY MEANS OF DETECTORS. Silar, Josef. Jad. Energ., 13: 173-9(May 1967). (In Czech).

The application possibilities of different types of beta-detectors for low activity and low concentration measurements in liquids are discussed. The recent state is evaluated and further improving possibilities are referred. The constants are tabulated for beta-radiation detectors which have been developed in the Nuclear Instruments Research Institute. (auth)

28254 METHOD FOR THE DETERMINATION OF RADIOACTIVITY IN AGAR BLOCKS BY LIQUID SCINTILLATION SPECTROMETRY. Naqvi, S. M. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). Nucleus (Lahore), 3: 57-9 (July-Sept. 1966).

A method for assaying radioactivity in agar blocks is described. It involves the use of liquid scintillation spectrometers whose efficiency is much higher than that of other detectors like G-M counters or gas flow spectrometers. (auth)

28255 MANUFACTURING OF THE WIDE-RANGE ION-CHAMBER DETECTOR. Tu, Cheng-chun; Chen, Kwo-chyuan (Union Industrial Research Inst., Taiwan). Ho Tsu K'o Hsueh, 5: No. 1-2, 39-43(Dec. 1966). (In Chinese).

A high-range radiation detector using a specially designed ionization chamber as the measuring input was manufactured. Its range was tested up to 500 r/hr. The success of this detector depends on a very high input resistance between the collector and the case of the chamber by putting an electrometer-type vacuum tube into the chamber and thus omitting grid leakages. The manufacturing details of the chamber and the circuit are presented. (auth)

28256 AN AUTOMATIC SCANNING AND PRINTING ANALOG-TO-DIGITAL DENSITOMETER. Gatzek, H. F.; Gordy, E.; Hasenpusch, P. (Roswell Park Memorial Inst., Buffalo). IRE (Inst. Radio Eng.) Trans. Bio-Med. Electron., BME 9: 81-4(Apr. 1962).

Techniques and instruments were developed for permitting more accurate calculation of dose distribution for radiotherapy and of delivering adequate dose levels to deeply situated tumors. Thus, lethal dose levels are attainable in the tumor while skin and healthy tissues in the path of radiation are spared serious permanent damage. Better knowledge of dose distribution was attained by construction of anatomical phantoms representing the patient. This was done by making radiographic cross sections with a transverse laminagraph at 1-in. intervals. After reducing the films to 1:1 scale with a camera lucida, they were cut out of tissue-equivalent wax plates and assembled. The phantom thus obtained represented the patient and his tumor, body fluids, etc., which might alter the position of the tumor and affect the uniformity of dose distribution. Then the dose distribution occurring under different conditions was measured, film densitometry being chosen as the most suitable method of dose measurement. An instrument was designed and constructed which eliminates the manual work of measuring and plotting densities of the films and enables the therapist to perform rapidly and automatically a multitude of dose-distribution studies in the phantom at several levels. The instrument automatically extracts the pertinent dose information of closely spaced density measurements of the film, which are translated into discrete dose levels in 10% increments and digitally printed by means of an electric typewriter. A contour map of close-spaced typographic patterns is obtained. Superposition of an anatomical overlay permits direct read-off of radiation dose to any organ present in the cross-section being studied. (BBB)

28257 PROBABILITY OF THE RECORDING OF STARS BY AN IONIZATION CALORIMETER. Denikaev, R. Z.; Emel'yanov, Yu. A.; Lukin, Yu. T.; Takibaev, Zh. S.; Khomenko, G. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1602-3(Oct. 1966). (In Russian).

Upon interaction of nucleus-reactive particles with matter, there is not only formation of new particles but also fission of nuclei of the target, which is accompanied by the emission of low-energy neutrons, protons, deuterons, and α-particles: i.e., formation of so-called "stars." The ionization produced by strongly ionizing particles of the stars is added to that due to electrons of the shower and measured, together with the latter, in an ionization calorimeter. On the basis of experimental data obtained on an instrument of the ionization calorimeter type, in which iron was used as an absorber, the contribution of stars to ionization was estimated at ~10% of the ionization due to the nuclear shower. (JPRS)

28258 SELF-ACTING COINCIDENCE OF THE SPARK COUNTERS. Saro, Stefan (Univ. Komenskeho, Bratislava). Mat. Fyz. Cas. Slov. Akad. Vied., 16: 91-6(1966). (In Czech).

An arrangement of spark chambers is described which results in the creation of a 3-fold coincidence circuit. The ability of spark chambers to create self-acting coincidences without special coincidence installation is discussed. (B.G.D.)

28259 ESTIMATING MICRODISTORTIONS IN TYPE R NUCLEAR EMULSIONS PREPARED UNDER VARIOUS CONDITIONS. Baranov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 1, 74-5(Jan.-Feb. 1967). (In Russian).

Thick-layered nuclear emulsion is subjected to stringent processing requirements in order to avoid possible distortion of particle tracks. Nuclear emulsion 400 μ thick from 5 different sources was subjected to different development treatments: standard production treatment, simplification of the dilution and washing treatment, laboratory treatment with periodic replacement of solution, treatment without changing the fixing solution with simplification of the dilution and washing, "rough" treatment with maximum simplification (no dilution), and treatment of unbacked emulsion. Simplification of the treatment (with the exception of the rough treatment) did not introduce any false distortions on measuring the multiple scattering of fast particles. Uniform gluing of the emulsion to the backing was important in avoiding distortions. The unbacked emulsions showed the greatest distortions. (TTT)

28260 METHOD FOR MEASURING THE DISPERSION OF DIRECTION MEASUREMENTS IN BUBBLE CHAMBERS. Gemeshi, T.; Krasnovski, Sh.; Lech', G. (Central Inst. for Physics Research, Budapest). Prib. Tekh. Eksp., No. 1, 58-60 (Jan.-Feb. 1967). (In Russian).

In measuring direction or angle, the error of the determination can be found independent of the track direction in the case of a chamber operating in a magnetic field. This statistical method is based on measuring the coordinates of points of the track on a photograph, and subsequently calculating the rise angle α of a spiral line at various points of the space curve. The rise angle should theoretically be a constant along the entire track. The expected mean should be zero for a number of measurements of $\Delta\alpha = \alpha - \alpha'$, that is, $M(\Delta\alpha) = 0$. A beam of 5 GeV π^--mesons were photographed in a one-meter propane chamber. A total of 130 measurements of $\Delta\alpha$ were carried out in seven equal intervals of the chamber volume in order to detect a difference of 0.01 between $M(\Delta\alpha)$ and the experimental mean at the 95% confidence level. It was found that $M(\Delta\alpha) = 0$ in spite of a systematic error in intervals 4, 5 and 6. An error can be corrected on the basis of taking into account the errors in neighboring intervals. (TTT)

28261 ALPHA SPECTROMETER WITH SEMICONDUCTOR DETECTOR. Poenaru, D. N.; Vilcov, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 243-51(1967).

An alpha spectrometer that uses a semiconductor detector is described with emphasis on the charge-sensitive vacuum-tube preamplifier and the combined mercury-relay pulser and power supply for the detector. The resolution of the system without optimization is better than 7 keV (full width at half maximum) if the detector capacitance does not exceed 10 pF. (D.C.W.)

28262 PRINCIPAL CHARACTERISTICS OF A MAGNETIC SPECTROMETER WITH FIELD VARIATIONS. Tarantin, N. I. Zh. Tekh. Fiz., 37: 375-83(Feb. 1967). (In Russian).

The dispersion and second-order angular aberrations were calculated of several variants of the magnetic spectrometer with field variations. This spectrometer is a multisection instrument with no intermediate images between the sections. Only such variants are discussed as are symmetric about the bisector of the angle of rotation of the radius vector of the principal ray. Values of the dispersion D, the reduced dispersion D/LG (where L is the source to image distance and G is the radial magnification), and the second-order aberration coefficient A, calculated for different versions of the field variation spectrometer and for different values of its characteristic parameters, are presented graphically and in tabular form and are compared with the corresponding quantities for axially symmetric magnetic spectrometers. The beam deflection in a field variation spectrometer is smaller than in a comparable axially symmetric spectrometer, and the aberrations of the former are therefore the more easily compensated. (ATD)

28263 NUCLEAR CASCADE PROCESS IN AN IONIZATION CALORIMETER. Denisov, E. V.; Dedenko, L. G.; Dubrovina, S. A.; Kotel'nikov, K. A.; Morozov, A. E.; Ogurtsov, O. F.; Sokolovskii, V. V.; Slavatinskii, S. A.; Fetisov, I. N. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1577-80(Oct. 1966). (In Russian).

Results of the calculation of the nuclear cascade process in an iron absorber were correlated with experimental data obtained on the ionization calorimeter of the Tyan'-Shan' Cosmic Ray Station. It was established that at E_0 = 300 BeV approximately 30% of the energy spent being carried away by strongly ionizing particles (black tracks), and the rest by protons with an energy of ~150 MeV (grey tracks). Errors in the measurement of E_0 = 200 BeV associated with fluctuations in the recording of strongly ionizing particles amounted to ~12% (~11% for black tracks and ~4% for grey tracks). In measurements by means of an ionization calorimeter of the energy transmitted to π^0 mesons, ionization produced by particles originating from nuclear splitting must be considered. (JPRS)

28264 A RADIOSPECTROGRAPH FOR MEASUREMENT OF SOLAR BURST SPECTA FROM 46 TO 540 MHz. Urbarz, H. (Univ., Tuebingen, Ger.). Z. Astrophys., 66: 321-38(1967). (In German).

The wideband solar-burst spectrum analyzer which is in operation at the Weissenau Radio Astronomy Station is described. The vertically polarized antennas —a group of four fishbone-yagis for the 46 to 86-Mc band and a group of six for the 86- to 160-Mc region— are mounted on a steel structure variable in azimuth and altitude, as is the log-periodic fed 7-m reflector covering the 160- to 1000-Mc band, which is triplexed from 160 to 290, 290 to 540, and 540 to 1000 Mc. Solar tracking is achieved by means of analog computer-controlled azimuth and elevation drive mechanisms. Four solid-state radiometers are electronically swept in the four lower bands while the 540- to 1000-Mc band is open. The retrace time is $\frac{1}{10}$ of the sweep time, which can be adjusted from 0.1 to 1 sec. The resulting frequency bands are displayed together on an oscilloscope which, along with the radiometer output, is controlled by a high-speed sampling device. A fiber-optic system transduces the multiple trace to one continuously filmed line. There are about 100 resolution elements in each of the bands distinguishable on film; the ratio of channel bandwidth to sweep width is about 200. The minimum detectable flux density is considered. Samples of burst spectra recorded during the Sept. 1966 period of solar activity are compared with other observations of connected events. (auth)

28265 STATISTICAL COUNTING PROBLEMS CONNECTED WITH AN EFFACEMENT SAMPLING. Bonnet, G. (Faculte des Sciences, Grenoble, France); Delcroix, V. Nucl. Instrum. Methods, 51: 213-23(1967). (In French).

An attempt is made to define a method of radiation measurements by means of a Geiger counter used in pulsed regime. The method is based on a statistical evaluation of the dose problem in pulsed regimes. Simple formulas that can be used directly were derived for the calibration of the pulsed device. It is shown that the counting duration is approximately Laplacian. A method is given for the estimation of the dose. The a posteriori distribution of the radiation dose is determined and the maximum probability is evaluated. A confidence interval and a detection probability are given. (J.S.R.)

28266 MEASUREMENT OF CONTINUOUS X-RAY SPECTRA WITH A SCINTILLATION SPECTROMETER. Alginger, H. (Oesterreichische Hochschule, Vienna). Atomkernenergie, 12: 115-19(Mar.-Apr. 1967). (In German).

The necessary corrections which must be applied to the pulse-height distribution derived from a NaI(Tl) crystal spectrometer in order to obtain the true photon spectrum are discussed for the energy range from 0–400 keV. The described method considers corrections caused by the following effects: Compton effect, Jod-escape (about 30% at 33.2 keV), limited resolving power, total intrinsic efficiency, absorption in the front window of the crystal, nonlinearity of a NaI(Tl) spectrometer below 180 keV. Corrections for the first four are made by means of a response matrix. The method of determining the matrix and the other corrections are described in detail. The method is especially useful in determining the shape of bremsstrahlung spectra at the high energy limit and the exact energetical value of this limit. Both properties are of considerable interest (shielding, filtration). (auth)

28267 EXPOSURE RATE MEASUREMENTS OF X AND GAMMA RAYS WITH SILICON RADIATION DETECTORS. Scharf, Karl (National Bureau of Standards, Washington, D. C.). Health Phys., 13: 575-86(June 1967).

The steady-state dc current and voltage signals produced by X or gamma rays in silicon radiation detectors used either as photovoltaic cells or photodiodes are dependent on such circuit parameters as load resistance and bias voltage used in the exposure rate measurement. Non-linear exposure rate dependence of radiation-produced signals may result from choosing unsuitable circuit parameters, and no singular value of sensitivity or signal per unit exposure rate can be ascribed to an individual detector without specifying the circuit parameters used. Measurements are reported with silicon radiation detectors, especially of the diffused p–n junction type, illustrating these performance features, and a measuring method is suggested which makes it possible to measure with high precision the generated photocurrent at zero voltage applied at the detector, independent of circuit parameters and proportional to exposure rate over a wide range. Measurements using this method are reported for exposure rates ranging up to 10^5 R/hr of 30 kV X rays of 0.09 mm Al HVL, and from approximately 1 to 30 R/hr of ^{60}Co gamma rays. (auth)

28268 FLUCTUATIONS OF BEAM INTENSITY IN SPACE AND TIME. Conway, John M. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 156: 1365-76(Apr. 25, 1967). (UCRL-14958(Rev.2)).

The fluctuations in the counting rate of a particle detector are studied. The density matrix for the beam is arbitrary and the limiting cases of a coherent and an incoherent beam are treated in detail. The effect of a measurement on the wave function of a beam is treated in a fashion similar to that of Goldberger, Lewis, and Watson. The results for the correlation experiments performed by Hanbury Brown and Twiss and by Armstrong and Smith are developed. (auth)

28269 SOME RELATIVISTIC ODDITIES IN THE QUANTUM THEORY OF OBSERVATION. Bloch, I. (Vanderbilt Univ., Nashville). Phys. Rev., 156: 1377-84(Apr. 25, 1967).

The orthodox quantum theory of observations is summarized and then applied to particle detection. Probabilities and state vectors are worked out for instantaneous observations, at stated times, by one counter, two counters, and three counters. The same cases are then examined in the context of a relativistic theory. It is found that, if attempts are made to detect a given particle in two space-time regions that have space-like separation, the nonrelativistic probability formulas have to be supplemented by additional conditions, and the wave function of the particle being detected becomes ambiguous and noncovariant. This ambiguity does not affect any probabilities for observations whose effect on the wave function has already been taken into account, and these are, by implication, the only observations whose probabilities could possibly be affected by the ambiguities in question. Possible consequences of these results are briefly discussed. (auth)

28270 ABSOLUTE METHOD OF THE GAMMA-RAY BACKGROUND DETERMINATION BY MEANS OF NaI(Tl) SCINTILLATION COUNTER. Pensko, Jerzy (Central Lab. of Radiological Protection, Warsaw). Nukleonika, 12: 319-31(1967).

A method for absolute dose rate measurement of the gamma natural background by means of the NaI(Tl) scintillation counter is presented. The calibration factor was determined taking into account the angular response of the counter, energy response, the response of the counter to natural beta and cosmic radiation

and the radioactive contamination of constructing materials. This method allows one to determine the global gamma dose rate originating from natural and artificial (from nuclear explosions) background with the over-all error not exceeding ±7.5 per cent. The stability of the lower discrimination level (300 keV) was maintained better than within ±5 per cent. (auth)

28271 USE OF THE LIQUID SCINTILLATION COUNTER FOR THE ACTIVITY MEASUREMENTS OF ^{14}C IN POWDERS. Dorabialska, Alicja; Reimschuessel, Wladyslaw. Nukleonika, 12: 305-8(1967). (In Polish).

A direct method for measurement of low-energy β-radiation in powders insoluble in scintillators was elaborated. $Ca^{14}CO_3$, $Sr^{14}CO_3$, and $Ba^{14}CO_3$ powders were used. The method consists in placing the powder as a uniform thin layer on the bottom of the cell used for measurement and filled with the liquid scintillator. (auth)

28272 REMARKS ON FILM-LESS DETECTION SYSTEMS IN HIGH-ENERGY PHYSICS EXPERIMENTS. Maglic, B. C. (CERN, Geneva). pp 62-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The features of a missing-mass spectrometer, an instrument built at CERN specifically for the search of unstable mesons, are discussed in order to illustrate the tendencies of filmless detection systems. (B.G.D.)

28273 APPARATUS FOR MEASURING IONIZING RADIATION. Verster, J. L.; Wytzes, S. (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 755,208. Mar. 21, 1967. Priority date Apr. 19, 1962, Netherlands.

To keep the gas pressure the same in the measuring chamber in spite of temperature changes, the automatic regulating valve is supplemented with a second chamber having flexible walls. Placed between the gas supply and the measuring chamber, pressure in the latter remains constant so that the pulse amplitude which depends on the value of gas amplification, is not changed and an accurate measurement of ionizing radiation may be obtained. (F.S.A.)

28274 LARGE VOLUME LITHIUM-DRIFT DIODES. Tavendale, A. J. (to Atomic Energy of Canada, Ltd.). Canadian Patent 759,633. May 23, 1967.

To secure a greater sensitive volume by increasing the area and drifted depth, lithium is diffused over the entire side surfaces of a p-type crystal. A bias voltage is applied between these surfaces and an electric contact is placed centrally of an end surface not diffused with lithium. Heating in a controlled atmosphere allows drifting to take place inwardly from the side surfaces leaving a coaxial core of p-material of small size in the central region. Thus the lithium is diffused on all surfaces except one. (F.S.A.)

28275 MEASUREMENT OF NEUTRON CURRENT DENSITY. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,059,377. Feb. 22, 1967. Priority date Dec. 7, 1962, Germany.

A description is given of a device for measuring neutron current density, comprising a neutron current measuring probe inside a detection chamber. One of the walls of the chamber is provided by a plate of moderator material and the other walls consist of neutron reflectors. The measuring probe is air-spaced from the reflecting walls. When neutron current enters the chamber through the moderator plate, the spectral range of the neutrons is determined by the lengths of the paths which those neutrons must travel in the moderator material of the plate. (S.F.L.)

28276 GAZORAZRYADNYE SCHETCHIRI FOTONOV. (Photon Gas Discharge Counters). Pavlova, E. N. Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1966. 110p.

The design, working mechanism, and performance of gas discharge photon counters are described. The methods for determining the spectral sensitivity of the counters, the nature of the dark and false pulses in the counter and the circuitry for pulse counting are discussed. The performance and efficiency of gas discharge photon counters and other photon counters are compared. (R.V.J.)

28277 LOW BACKGROUND RADIATION DETECTION. (to Beckman Instruments Inc.). British Patent 1,070,657. June 1, 1967. Priority date Oct. 28, 1963, United States.

A radiation detection system is described which is composed of a beta detector and cosmic ray detector connected with an anticoincidence circuit and shielding surrounding both detectors. (B.G.D.)

28278 IMPROVEMENTS IN OR RELATING TO RADIATION SPECTROMETERS. (to Japan Atomic Energy Research Inst.). British Patent 1,070,403. June 1, 1967. Priority date May 21, 1963, Japan.

A neutron spectrometer is described which consists of a cylinder containing gases such as butane, propane, or hydrogen and many inner electrode wires at various potentials. The system performs simultaneously as a proportional counter, ionization chamber, and Geiger–Mueller counter. (B.G.D.)

Radiation Dosimeters

Refer also to abstracts 27928, 28252, 28256, and 29661.

28279 (CERN-67-14) VISCOMETRIC DOSIMETER OPERATING IN THE RANGE 5×10^4 TO 5×10^7 RAD. Van de Voorde, M. H. (European Organization for Nuclear Research, Geneva (Switzerland)). May 9, 1967. 22p. Dep.

When the decrease due to irradiation of the average molecular weight of polymethylmethacrylate is known, the dose absorbed can be calculated. The change in molecular weight was measured by an Ubbelohde viscometer. Benzene, chloroform, and acetone were used as solvents. The reported range is from about 5×10^4 to 5×10^7 rad, and the accuracy of this dosimeter is within 10%. This dosimeter was compared with a Fricke dosimeter, an ionization chamber, and a calorimeter, which were used during irradiation by a cobalt source, spent fuel rods, a linear electron accelerator, and a nuclear reactor, respectively. The viscometric dosimeter provides a direct method for the determination of the total energy absorbed in the mixed radiation field around accelerators. However, the method is not simple and is time-consuming, thus making it not generally suitable for routine use. It does approach the goal of absolute dosimetry, however, and is particularly useful for the calibration of other dosimeters. (auth)

28280 (IA-1095) AUTOMATIC DATA PROCESSING FOR A NATIONAL FILM DOSIMETRY SERVICE. Benari, W.; Schatz, M.; Ben-David, G. (Israel Atomic Energy Commission, Hakirya). Aug. 1966. 32p. Dep.

Automatic data processing was applied to the operation of the Soreq Dosimetry Service. The use of an electronic computer results in considerable saving of manpower, a reduction in the errors incurred, and convenient storage of all the recorded dosage statistics on magnetic tape. (auth)

28281 (ZfK-Dos-5) ENTWICKLUNG EINER FLACHKAMMER ZUM VA-J-15 SCHWINGKONDENSATORELEKTROMETER FUER β-DOSISLEISTUNGSMESSUNGEN IM STRAHLENSCHUTZ. (Development of a Flat Ionization Chamber for the VA-J-15 Vibrating Condensor Electrometer for β Dose Rate Measurements in Radiation Protection). Rossbander, Werner; Haberer, Gudrun (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). July 1966. 17p. (In German). Dep.

The development of a flat ionization chamber for use with a portable vibrating condensor electrometer is described. The chamber allows the measurement of beta dose rates in the range from 10 mrad h^{-1} to 1000 rad h^{-1} within an error of $\leq \pm 40\%$ for beta radiations with maximum energies between 0.2 and 3.5 MeV, angles of radiation incident between 0 and ±60°, and distances between the source and the chamber of ≧10 cm. (auth)

28282 IMPROVED METHOD OF ADJUSTING THE HEATING CONDITIONS OF INTEGRATING THERMOLUMINESCENT DOSIMETRY SYSTEMS. Webb, G. A. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Sci. Instrum., 44: 481-3 (June 1967).

Readings for a first and second heating cycle, with different heating currents, are obtained for samples from a batch of phosphor exposed to a known dose. The optimal current setting corresponds to that for the minimum value of reading from the second heating cycle, and varies with the dose range and type of exposure (e.g., gamma or neutron radiation) used. The method applies for phosphor in the form of loose crystals or in Teflon disks. (auth)

28283 EXPOSURE METER EMPLOYING IONIZATION CHAMBERS. Tanaka, Osamu; Ikeda, Hiroshi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Giho, 7: 233-45(Oct. 1966).

Exposure meter employing ionization chambers, over the energy range from 40 keV to 1.3 MeV and over the range of exposure rate from 1 mR/min to 100,000 R/min of x and gamma ray, was constructed. The ionization chambers, especially being available to the pulsed radiation of high intensity of more than 1,000 R/min, were also investigated and developed. Experiments and calibrations were made using ^{60}Co gamma sources (300 KCi, 10 KCi, and 30 Ci), the LAS-M Electron Linac, and the Mitsubishi 30 MeV Betatron. Good agreements between calculations and experiments of saturation curves and of the radiation exposure rate were obtained. (auth)

28284 DOPING METHODS AND SOME THERMOLUMINESCENT AND DOSIMETRIC PROPERTIES OF LiF:Cu,Ag AND

CaF_2:Mn. Niewiadomski, Tadeusz (Inst. of Nuclear Physics, Krakow). Nukleonika, 12: 281-301(1967).

An easy and reproducible method of LiF:Cu, Ag preparation from pure grade reagents and a modification of the Ginther and Kirk method of CaF_2:Mn preparation, requiring a temperature of only 850°C and a few minutes of time, was elaborated for dosimetric purposes. The high luminescence yield and the low spurious luminescence of LiF:Cu, Ag used as a loose powder allow one to detect a 1 mr dose and low errors at small doses. Because of the higher background of CaF_2:Mn in spite of its high luminescence yield, its sensitivity threshold lies at 0.1 rad. A single glow peak of LiF:Cu, Ag appears at about 120°C and the fading of stored energy is 22% after 10 days and 33% after 20 days at room temperature. On the contrary CaF_2:Mn exhibits the mean glow maximum at about 240°C, and no fading was observed at room temperature during 30 days. The linearity of dose response extends up to at least 4×10^4 r for LiF:Cu, Ag, and only to 10^3 r for CaF_2:Mn. Both phosphors can be re-used several times without any change in their properties. Since the use of the phosphor in loose powder form is inconvenient, methods of constructing dosimeters consisting of an agglomerate of dosimeter material with a teflon base as small 8-mm discs were elaborated. (auth)

Radiometric Instruments

Refer also to abstracts 27928 and 28176.

28285 (EUR-3269.d) DICKENMESSUNG AN HEISSEN GLASBAHNEN BEI DER HERSTELLUNG VON TAFELGLAS. (Thickness Measurements on Hot Glass Sheets in the Manufacture of Plate Glass). Langel, H. (Frieseke und Hoepfner G.m.b.H., Erlangen-Bruck (West Germany)). Feb. 1967. 38p. (In German). Dep.

Three prototype devices employing α transmission techniques using ^{241}Am sources were developed for measuring thicknesses in plate glass manufacturing. The three devices all show promise. One device, which is very expensive, is used in the cooling furnace. The other devices, which are less expensive, are used behind the cooling furnace and during vertical drawing. (F.S.)

28286 (RT/ING-(66)10) MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ O X. (Volumetric Fraction Measurement of Vapor by γ or X-Ray Attenuation Method). Baran, W. J.; Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 142p. (In Italian). Dep.

A general method for calculating energy and activity of a γ-source for void fraction measurement by the attenuation method is described. The results obtained for test-sections of different shapes and dimensions are discussed. Besides a detailed analysis of a scintillation counter for detecting γ-rays of low energy is made. (auth)

28287 MEASUREMENT OF THE HOLD-UP OF RAW MATERIAL IN THE ROTARY KILN. Tanaka, Masaaki; Kobuchi, Kunio (Ube Ind., Ltd., Japan). FAPIG (Tokyo), No. 41, 126 (July 1966). (In Japanese).

An improved method was developed for measuring the moving angle of repose of raw material in the kiln. The measuring instrument was previously placed on the ground. In the new method, the radiation source and detector are located on the circumference outside the kiln and both are rotated at the same rate as the kiln. With the relation between the detected amount and the rotating angle in the x-y axis, the bottom value of the concaved curve shows the moving angle of repose. By this means, the apparent moving angle of repose can be avoided. ^{60}Co 1 Ci is used as the source and a scintillation probe as the detector. The moving angle of repose and the packing-ratio are 6° and 7%, respectively when the kiln is run in the normal operation; they are 45° and 4.5% when the kiln is stopped. These values are far smaller than those usually expected, which indicate the considerable aeration due to CO_2 in the kiln. (NSA of Japan)

28288 DUAL-ENERGY GAMMA-RAY TRANSMISSION FOR COINCIDENT MEASUREMENT OF WATER CONTENT AND DRY BULK DENSITY OF SOIL. Soane, B. D. (National Inst. of Agricultural Engineering, Penicuik, Scotland). Nature, 214: 1273-4(June 17, 1967).

It was found that the ratio between the theoretical absorption coefficients of water and concrete (the total composition of which is similar to that of most soils) depended markedly on photon energy below 100 keV, but only slightly at higher energies. This suggested that it might be possible to measure attenuation using two widely differing primary photon energies and then solve simultaneous equations for the mass thicknesses of soil and water. Where the sample thickness is constant, values of mass thickness can be replaced by units of mass/volume. Sources employed in experimental work were ^{241}Am and ^{137}Cs, giving low and high photon energies, respectively. Detection was by thallium-doped NaI scintillator. Count rates for the 60 and 660 keV photopeaks were measured, in turn, for both the low-energy and high-energy sources. No collimation was employed, but this did not affect the principle or accuracy of the method provided the geometry remained constant. Experimental results are tabulated. It would seem that the accuracy is likely to be acceptable for many purposes, and capable of improvement. (UK)

28289 TRACER ISOTOPE CONTROL IN SUBSURFACE COMPRESSION WORK ON THE HIGHWAY. Duftschmid, K. E. (Reaktorzentrum, Seibersdorf, Austria). Atomwirtschaft, 12: 125-6(Mar. 1967). (In German).

For repair work on highways, cavities occurring under the concrete were filled with bitumen forced in under pressure. By radioactive labeling of the bitumen material using ^{24}Na-labeled-naphthenate the extent and thickness of the bitumen layers introduced under the highway can be easily controlled. Optimization of this relatively expensive operation possesses considerable economic significance. (tr-auth)

28290 MEASURING SYSTEM ANALYSIS OF X-RAY THICKNESS GAGES. Yoshiyama, Yuji; Obata, Hajime (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Giho, 7: 271-87(Oct. 1966).

Several errors due to the varieties of the measuring systems of X-ray thickness gauges are analysed and experimentally tested in part. The measuring system of X-ray gauges usually involves the two beam system or one beam system. The sensitivity, deviation error, statistical error, and measuring error are discussed. From the point of view of accuracy, the two beam system is superior to the one beam system when the coincidence error is more than 0.4 times of random error, as the accuracy is limited by the fractuation of many factors in one beam system. (NSA of Japan)

28291 A THIN TUBE, INSERTION TYPE γ-RAY DENSITY METER. Arizumi, Masashi; Nishigaki, Yoshihiko (Kajima Construction Co., Ltd., Japan). Kashima Kensetsu Gijutsu Kenkyusho Nempo, No. 14, 131-6(Jan. 1966). (In Japanese).

Although various γ-ray density meters and neutron moisture meters are sold, it is necessary to improve these meters so as to be readily used. A thin tube, insertion type γ-ray density meter was constructed in trial to give a small compact and versatile density meter. It consists of a γ-ray source, lead shield, thin tube GM counter (plateau voltage, 400–700 V, and plateau gradient 1–2.5%), preamplifier with a coaxial electric cable, and brass envelope tube (16 mm in diameter and 550 mm long). The effects of various parameters, including the length of the lead shield (17, 20, and 24 cm), material of the access tube (polyvinylchloride, out-side diameter 26 mm and thickness 3 mm; and steel, out-side diameter 33.5 mm and thickness 8 mm), and the position of the probe in the actual measurements, were studied to obtain the maximum count rate and the optimum time (3 min) of measurement. Good results were given by the use of the lead shield 17 cm long and the access tube made of polyvinylchloride. Examples of practical use of this density meter in the embankment are also given. (NSA of Japan)

28292 PROCEDURE FOR CALIBRATING NEUTRON MOISTURE PROBES IN THE FIELD. Cohen, O. P. (Volcani Inst. of Agricultural Research, Rehovot, Israel). Israel J. Agr. Res., 14: 169-78(Dec. 1964).

A description is given of a procedure for field calibration of the soil moisture probe during the placement of the access tube. The possible displacement of the neutron source from the sensitive center of the probe is taken into account, and an empirical procedure is described for determining the sample volume which yields the least error in the resulting regression. Calibration of three Israel soils with the same probe indicated that each soil requires its own calibration. (auth)

28293 ECONOMICS OF ISOTOPIC BLAST-FURNACE BATCH LEVEL INDICATORS. Abelovszki, Laszlo (Isotope Inst. of the National Atomic Energy Commission, Hungary). Atomtech. Tajek., 9: 615-23(1966). (In Hungarian).

A level indicator operating with two fixed ^{60}Co sources was installed in April 1964, in one of the blast furnaces of the Danubian Iron Works, to automatically record the batch level and to control the loading unit. The information obtained by the sensors was recorded on paper tape, then transmitted to the control room, where instructions to add ore, coke, or limestone are given. The sensors were water-cooled. After more than one year of operation, the device was found to operate more reliably than previously used mechanical probes; it also gives information about the shape of the surface because four points are used for measurements. Uneven operation of the furnace may easily be detected and the unit may be repaired without interfering with the loading operation. By use

of electronic data processing, the level was maintained at the desired value. After the instrument was installed iron production of the furnace increased by 2.6% and the specific coke consumption was improved by 6.5%. (auth)

28294 POSITION INDICATING APPARATUS. (to Industrial Nucleonics Corp.). British Patent 1,070,955. June 7, 1967. Priority date Sept. 19, 1963, United States.

A digital output device for indicating position is described that involves several radiation detectors with a rotatable source. (R.E.U.)

28295 TRANSDUCER APPARATUS FOR MEASURING VARIATIONS IN A PHYSICAL VARIABLE. (to Industrial Nucleonics Corp.). British Patent 1,070,954. June 7, 1967. Priority date May 27, 1963, United States.

A radiation source plus detector arrangement for the measurement of mechanical displacements, velocities, accelerations, temperatures, pressures, and thicknesses is described in which the radiation field (and in some cases an intermediate mechanical transducer) is used to couple the variable measured to an element whose output is an electric signal. The detector is of the backscatter type. (R.E.U.)

Miscellaneous Instruments and Components

Refer also to abstracts 29009, 29388, 29941, and 29942.

28296 (AAEC/M-74) DIGITAL VOLTMETER READ-OUT SYSTEM TYPE 173. Ellis, P. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1966. 28p. Dep.

A description is given of a digital voltmeter read-out system developed for use with a square-wave reactivity oscillator for the research reactor MOATA. The functions and operating details are given and typical subunits are described. The system uses standard modular logic cards. (auth)

28297 (AERE-R-4534) AUTOMATION OF A PHILIPS X-RAY SPECTROGRAPH. Campbell, J. T.; Hammond, T. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 34p. Dep. CFSTI. UK 4s. 6d.

A Philips fluorescent x-ray spectrograph (TYPE PW1520) was converted for continuous automatic operation, whereby a printed record of angle, counts, and time is made for ten angles which are preselected by the operator. The cycle repeats itself until stopped manually, so that the equipment can be left running unattended for long periods, thus making possible to record during silent hours. Some examples are given demonstrating the advantages in analysis of the automated equipment. (auth)

28298 (BNWL-343) ANALOGUE-DIGITAL-MAGNETIC TAPE CONVERSION SYSTEM. Morrey, J. R.; Gile, H. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 198p. Dep. CFSTI.

An analog-digital-magnetic tape data conversion system which includes an analog generating instrument, a biquinary scaler, a digital voltmeter, a serial number device, a tape coupler, and a paper tape punch is described. The system was specifically designed for absorption spectra created by either the Cary Model 14 spectrophotometer or the Perkin Elmer Model 521 spectrophotometer but can be easily adaptable if the nomenclature and record formats used in the associated computer programs are the same and the extra slide wire and triggering systems are installed. (auth)

28299 (HW-78862) CRITICAL INCIDENT ALARM MODEL II INSTRUCTION AND MAINTENANCE MANUAL. Oliver, R. G. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 6, 1963. Contract AT(45-1)-1350. 14p. Dep. CFSTI.

An instruction and maintenance manual is presented for an instrument designed to give an audible and visual alarm signal in the event of a critical incident to which it is exposed. (B.G.D.)

28300 (IFA-IS-41) CYCLOTRONIC MASS SPECTROMETER WITH NON-ACCELERATING SYNCHRONOUS ION. Mercea, V. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1967. 23p. Dep.

An efficient operating mode of a cyclotronic mass spectrometer (synchrometer) with non-accelerating synchronous ions was theoretically investigated. (B.G.D.)

28301 (IPP-4/39) DISTRIBUTION OF VOLTAGE IN A CAPACITOR IN RESPONSE TO APPLIED PULSES. Bayes, D. V. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1967. 18p. Dep.

A capacitor was tested with pulse rise-times between 30 nsec and 3.6 μsec and the distribution of internal voltages plotted. The capacitor was also driven with a power oscillator in the frequency range 1 kc to 5 Mc and the internal voltage plotted as a percentage of the terminal voltage. (auth)

28302 (IPP-4/40) TESTS ON A MASTER GAP WORKING AT ATMOSPHERIC PRESSURE. Bayes, D. V. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1967. 20p. Dep.

A master gap has been tested and graphs of jitter and delay against charging voltage are presented for two gap ratios, different numbers of cables connected, and different values of center electrode capacitance. In addition the pulse rise-time has been plotted against charging voltage and against the number of cables connected. (auth)

28303 (JINR-P13-3275) ANALIZ ZARYADNOGO USTROISTVA AMPLITUDNOGO KODIROVSHCHIKA POVYSHENNOI TOCHNOSTI. (Analysis of a Charging Device for an Amplitude Coder of High Accuracy). Semenov, B. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 34p. (In Russian). Dep.

The problems concerning the dynamics of a charging device with a negative feedback are considered. Simple expressions of a good approximation are obtained for transfer functions: of separate cascades, open and closed systems, and of a device as a whole. The stability and the transient response are analyzed. Theoretical calculations are proved by numerical examples and by experiment. (auth)

28304 (KFK-552) EIN KATHODENSTRAHLROHR ALS SCHNELLER VIELFACHSCHALTER MIT HOHEM EINGANGS-WIDERSTAND. (A Cathode Ray Tube as Fast Multiplier With High Input Resistance). Weigele, Klaus (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Feb. 1967. 21p. (In German). Dep.

A multiple switch was developed, by means of which numerous high impedance sources (e.g. capacitances) can be scanned by an electron beam for both positive and negative voltages. The model described has nine input channels having input impedances between 10^{11} and 10^{12} ohms if the switch is off. Scanning of each channel takes about 100 μsec. Positive voltages up to 10 V and higher and negative voltages up to about −2V can be transferred linearly. Several improvements are discussed. (auth)

28305 (ORNL-TM-1638) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 1. CHAMBER VOLTAGE MONITOR AND TEST UNIT, ORNL MODEL Q-2601. Anderson, J. L. (Oak Ridge National Lab., Tenn.). Apr. 13, 1967. Contract W-7405-eng-26. 16p. Dep. CFSTI.

A Chamber Voltage Monitor and Test Unit, a special purpose module, was designed to supply signals for testing the response of parts of a reactor safety system utilizing ORNL modular reactor instrumentation, series Q-2600. The unit supplies a calibrated current ramp at two different rates for checking the response and approximate calibration of both neutron flux level and rate-of-change-of-flux-level trips and associated signal amplifiers, an adjustable steady-state test current, and a circuit which continuously monitors ion chamber polarizing voltage. The circuit, application, maintenance procedures, and acceptance tests for the unit are described. (auth)

28306 (ORNL-TM-1865) ANALYSIS OF PULSE-HEIGHT ANALYZER TEST DATA WITH A SMALL COMPUTER. McDaniel, E.; Woody, J. W. Jr. (Oak Ridge National Lab., Tenn.). May 17, 1967. Contract W-7405-eng-26. 56p. Dep. CFSTI.

All multichannel pulse-height analyzers purchased by ORNL are tested to determine whether they are acceptable to the Laboratory. A PDP-8 computer program was prepared for evaluation of these test data, that is, to determine the extent of the integral and differential nonlinearities of the instruments. The program will also examine smooth spectra of radioactive decay. (auth)

28307 (RT/EL-(66)-15) ELABORAZIONE DI UN ANALIZZATORE LABEN A 512 CANALI PER ANALISI MULTIDIMENSIONALI AD ALTA RISOLUZIONE. (Modification of a 512 Channel LABEN Analyzer for High-Resolution Multidimensional Analysis). Castrica, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 17p. (In Italian). Dep.

The modification of a LABEN-A512 analyzer is described with the purpose to allow high resolution multiparameter analysis. (auth)

28308 (SCL-TN-67-42) LIGHT-ACTUATED TRIGGER GENERATOR. Olson, H. W. (Sandia Corp., Livermore, Calif.). May 1967. Contract AT(29-1)-789. 1p. Dep. CFSTI.

The trigger generator described provides a trigger pulse to

synchronize recording equipment with the position of a mechanical device. Trigger-point repeatability is less than 0.001 inch. The generator can be used with any dc supply of about 40 V and 0.33 A. (auth)

28309 (UCID-15126) ADIABATIC CALORIMETRIC MEASUREMENTS OF X-RAY INTENSITY. Taylor, Grover M. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 4, 1967. Contract W-7405-eng-48. 7p. Dep. CFSTI.

A method for measuring x-ray intensity by adiabatic colorimetric measurements is described. The theoretical aspects, equipment used, and performance of the method itself are discussed. (B.G.D.)

28310 (UCRL-50233) METHOD FOR THE NUMERICAL ANALYSIS OF PRESSURE TRANSDUCER RECORDS. Wasley, Richard J.; Walker, Franklin E. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 10, 1967. Contract W-7405-eng-48. 11p. Dep. CFSTI.

This report describes a mathematical treatment and an associated FORTRAN program that are used in the analysis of pressure transducer records obtained in one-dimensional strain impact experiments. (auth)

28311 (AD-645794) CERTAIN QUESTIONS IN EXPERIMENTAL PHYSICS (COLLECTION OF ARTICLES). Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1-124(1959). 162p. (FTD-MT-64-178). CFSTI.

Separate abstracts are prepared for 6 of the 13 papers presented. Three papers were previously included in NSA as 13: 10368, 13: 19172, and 14: 15566. Four papers were not abstracted since they were not within the scope of NSA. (B.G.D.)

For abstracts of individual papers see: 28158, 28217, 28312, 28313, 29681, and 29682.

28312 (AD-645794, pp 25-45) CALCULATION AND EXPERIMENTAL CHARACTERISTICS OF AN INSTRUMENT FOR THE MEASUREMENT OF A STABLE NUCLEAR REACTOR PERIOD. Popov, P. I. Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1959.

A method for calculating and the operational theory of an electronic system used to measure the stable period of a nuclear reactor are presented. This instrument is built on the basis of a logarithmic method of measurement. Experimental static and dynamic characteristics of the instrument are presented. Since a magnetic oscillograph, with small load resistance, is used for the measurement of a period, considerable attention is allotted to the calculation of the output stage of the electron amplifier. Dynamic characteristics are illustrated by oscillograms, obtained for different values of established periods. (auth)

28313 (AD-645794, pp 59-63) CALCULATIONS OF MAGNETIC POLE PROFILES. Irodov, I. E. Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1959.

A method is described for calculating profiles of poles of charged particle magnetic analyzers from given field distributions in the plane of symmetry (without consideration of the edge effect). This method applies to radial-symmetric and plane-parallel fields and is based on the solution of potential problems with the use of cubic equation tables. (auth)

28314 RADIONUCLIDE SCANNER AND ANALOGUE COMPUTER COUPLING. I. USE FOR VARYING ORGAN CONTENT, AND ALLOWING FOR RADIODECAY WITH ONE OR MORE RADIONUCLIDES. Spencer, Richard P. (Yale Univ., New Haven). Int. J. Appl. Radiat. Isotop., 18: 421-7(1967).

Some present limitations to the use of rectilinear scanners can be circumvented by coupling the scanner directly to an analogue computer. With such coupling it is possible to scan one radionuclide in the presence of a second, or to scan two radionuclides simultaneously. The rapid decay of radionuclides with half-lives of the order of a few minutes can be automatically corrected. Use of these short-lived radionuclides, which deliver a small radiation dose, should allow scanning to be extended to children and to pregnant women. Potential uses of the scanner-plus-computer coupling to correct for varying background or organ content are discussed. Although digital techniques allow greater sophistication, the analogue system is inexpensive, on-line, and compatible with present rectilinear scanners. It is suggested that these techniques are also adaptable for use with gamma-ray cameras and related devices. (auth)

28315 IMPROVED TECHNIQUE FOR RECORDING TRANSIENT ELECTRON SPIN RESONANCE SPECTRA. Bennett, T. J.; Smith, R. C.; Wilmshurst, T. H. (Univ. of Southampton, Eng.). Chem. Commun., No. 11, 513-14(June 7, 1967).

Preliminary results are described using an improved technique for recording the ESR spectra of transient photolytically generated free radicals. The test sample is placed in a slotted microwave cavity of a conventional spectrometer and irradiated with 50 J, 100 μsec. flashes from a xenon tube at a rate of one flash every 1.5 sec. At a fixed magnetic field the spectrometer output describes the radical decay curve (the radical lifetime must be much smaller than the time between flashes). After each flash the output is monitored by six different sampling channels, each with an open time of 1.5 μsec. (much smaller than the radical lifetime), and with the sampling times suitably distributed over the decay curve. The 1.5 μsec. pulses from each channel are stretched to last until the next flash. The magnetic field is then swept slowly and linearly in the usual way, taking ten minutes to traverse a complete spectrum. The output from each channel is thus a normal ESR display and represents the spectrum for a particular time interval after the flash. A typical set of spectra is shown. (UK)

28316 PROPOSAL FOR A MULTIPLE STOP TIME-TO-PULSE-HEIGHT CONVERTER. Kowalski, E. (Univ. of Bern). Nucl. Instrum. Methods, 52: 357(1967).

A multiple stop time-to-pulse-height converter is proposed based on the principle of sampling a voltage ramp by the standardized stop pulses. The resulting voltage pulses are stored in an analog butter memory prior to their analysis in an ADC. (auth)

28317 SIMPLE METHOD TO CALIBRATE A TIME-TO-PULSE-HEIGHT CONVERTER. Cho, Z. H.; Gidefeldt, L.; Eriksson, L. (Univ. of Stockholm). Nucl. Instrum. Methods, 52: 273-6(1967).

A simple and quick method to make an absolute time calibration of a time-to-pulse-height converter (TPHC) was developed. The method is also suitable for quantitative determination of the differential linearity of a TPHC. In addition to ordinary laboratory instruments two fast gating systems and a simple TD pulse shaper are needed. The circuits are described in detail together with the overall system. The results of a linearity test of a commercial TPHC in two different conversion ranges are presented. (auth)

28318 STUDY OF A VERY HIGH VOLTAGE GENERATOR (kV RANGE) UTILIZING TRANSISTORS IN THE AVALANCHE REGION. Schmitt, F.; Metzger, G.; Riedinger, M.; Sutter, G.; Chevallier, P. (Institut de Recherches Nucleaires, Strasbourg. Univ., Mulhouse, France). Nucl. Instrum. Methods, 52: 331-7 (1967). (In French).

A high voltage pulse generator using 18 avalanche transistors in a modified Marx bank circuit is described. For input pulses of about 500 mV this generator yields output pulse amplitudes of 1.7 kV, a delay of 7.ns and a rise time better than 3 ns. An analysis of the performances is given. (auth)

28319 ANALYSIS OF Q-METERS USED FOR MEASUREMENT OF ENHANCED NUCLEAR POLARIZATION. Petricek, V.; Odehnal, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez. CEN, Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods, 52: 197-205(1967). (In French).

A general expression was derived for the admittance of a resonant circuit including a coaxial cable and deformations of the magnetic resonance lines of protons observed with different types of Q-meters used in polarized targets experiments were calculated. A value of the correction which must be applied to the coefficient of enhancement measured to calculate the exact value of the polarization of the polarized target was determined from this analysis. (auth)

28320 VACUUM CHAMBER FOR NUCLEAR SCATTERING EXPERIMENTS. Borsay, F. L. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 52: 338-40(1967).

A 24" dia scattering chamber of the sliding strip type with a 3" by 153° slot for use with a double focusing magnetic spectrometer is described. (auth)

28321 STUDY OF TWO DETECTOR CORRELATION METHOD FOR NOISE MEASUREMENTS. Ko, Y. C. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 5: No. 1-2, 45-9 (Dec. 1966).

A difficult problem arising in reactor noise measurement is that the uncorrelated signal is large compared to the correlated signal for high frequencies. Usually one detector auto-correlation method is used to reduce the effects of the uncorrelated signal. However, the results would be much improved if two-detector crosscorrelation method were applied. A theory concerning the correlation method is demonstrated and its application is discussed. The results show that the transfer function obtained is similar to that obtained by one detector-correlation method. (auth)

28322 CATHODE DROPS IN ARC DISCHARGES IN PURE METAL VAPORS. I. Grakov, V. E. Zh. Tekh. Fiz., 37: 396-404(Feb. 1967). (In Russian).

The cathode drops in vacuum (10^{-4} to 3×10^{-5} mm Hg) arcs between pure electrodes of 36 different elements have been measured, and the results are presented in graphical and tabular form. The arc current was supplied by a 22- to 35-V storage battery through a noninductive current-limiting resistor, and the arc was struck by automatic separation of the electrodes at a rate not exceeding 2 cm/sec. In all cases the cathode, and in most cases the anode, was of the investigated metal, and care was taken to assure purity of the electrode surfaces. The arc current and the potential difference between the electrodes were recorded as functions of time with a loop oscillograph. The potential difference between the arc electrodes was taken as the cathode drop; this is justified theoretically by the low value expected for the potential drop in the column of an arc burning in pure metal vapor, and experimentally, by the observed time independence of the measured electrode potential difference during separation of the electrodes. (ATD)

28323 NUCLEAR ELECTRONICS: A MEDIUM-FAST LINEAR STRETCHER. Lauch, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 9: 157-60(Mar.-Apr. 1967). (In German).

A linear stretcher used in measurement setups for pulse-shape discrimination and pulse-height analysis of fast signals is described. Short pulses with a duration of 20 to 200 ns will be converted into rectangular pulses with proportional amplitude and adjustable width between 0.2 and 2 μs. The unit is designed for positive and negative input signals with amplitudes in the range of 40 mV to 2 V and has a gain of 6. In an amplitude range of 20:1 the nonlinearity is less than 1%. The rise-time of the stretched pulse is adjustable between 80 and 300 ns. A second output delivers the gate signal with –2V at 50 Ω. (auth)

28324 NUCLEAR HEATING MEASUREMENTS OF MATERIALS IN REACTORS BY A DIFFERENTIAL CALORIMETER. Wiegandt, M. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 12: 120-2(Mar.-Apr. 1967). (In German).

A differential calorimeter for nuclear heating measurements is described, consisting of three identical units, which are placed above each other within an aluminium tube. Two units are filled with absorbing samples (Aluminum, Zircaloy-2), the third remains empty. These three units are brought alternatingly into the same position of the reactor core. Some details are presented together with results concerning the γ-dose rate distribution along an in-core irradiation channel of the FRG swimming pool reactor. (auth)

28325 DETERMINATION OF COINCIDENCE-CIRCUIT STATISTICAL PARAMETERS BY MEANS OF THE POINT METHOD. Kalisz, J. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol., 31: 797-802(May 1967).

A simple method allowing determination of the resolving time, jitter breadth and efficiency of the twofold coincidence circuit is described. The method may be used at the assumption of Gaussian jitter distributions and is an alternative to the earlier published "slope method." Results of numerical calculations and an example illustrating the method are given. (auth)

28326 TARGET-CURRENT INTEGRATOR WITH DIGITAL READOUT. Korbel, Kazimierz; Mruk, Wieslaw (Inst. of Nuclear Research, Krakow). Nukleonika, 12: 313-18(1967). (In Polish).

A target current integrator was described, designed for use with the laboratory fast neutron generator and destined for the continuous measurement of the target wear grade. The principles of the measurement and the choice criteria of the measuring system were presented, as well as the technical data of the performed prototype apparatus. (auth)

28327 PULSE TRANSFORMER LINKS IN MEASURING LINES USING NEUTRON DETECTORS. Krzycki, Andrzej; Ostrowski, Andrzej (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 12: 333-46(1967).

Design principles of transformer input circuits and transformer links used in pulse measuring lines with neutron detectors are described. The circuits are divided into two groups according to the pulse amplifiers used: vacuum tube amplifiers with high input impedance; semiconductor amplifiers with low input impedance. The designs for both types of these circuits are described. A short description of the links developed is given. (auth)

28328 RECENT PROGRESS IN THE PERFORMANCE OF ELECTROSTATIC SEPARATORS AT CERN. Germam, C. (CERN, Geneva). pp 545-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Some of the advances in electrostatic separator techniques at CERN are described. The operating conditions achieved using conventional stainless steel electrodes, provided organic vapor contamination is minimized: gap width 10 cm, applied voltage 550 to 600 kV; gap width 14 cm, applied voltage 700 to 740 kV is discussed. Research on high voltage vacuum breakdown phenomena is described. A search on improved electrodes was made and it was found that by using a cathode coated with a thin insulating layer and a conventional stainless steel anode the performance of a 3 meter separator can be doubled. (B.G.D.)

28329 PULSE GENERATORS FOR DELAY LINE DEFLECTORS. van Breugel, H.; Goni, J.; Kuiper, B. (CERN, Geneva). pp 731-41 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The design characteristics of line type pulsers for delay-line magnets are presented. These are impedance level pulse shaping, switching, and pulse transmission. Other aspects discussed are pulse forming network, main sparkgap, short circuit sparkgap, and triggering and controls. (B.G.D.)

28330 PERIODIC INTEGRATING DEVICE FOR MEASUREMENT OF RAPIDLY VARYING COUNT RATES. Kukla, Cassimer M. (Ford Motor Co., Dearborn, Mich.). Rev. Sci. Instrum., 38: 804-6(June 1967).

A device for the measurement of rapidly varying counting rates is described. The input signals, which need not be of constant size or shape, are converted into pulses of constant width and constant current. The pulses are applied to an integrating capacitor where, at the end of an integral period, the voltage of integration is sampled and stored. The sample is in storage for an integral period and is displayed on a chart recorder, while the integrator is accumulating counts for the next sample. With this method the recorder is required only to indicate the number of counts per period. The device has been used in conjunction with a conventional scintillation counter, a radioactive tracer, and a chart recorder to obtain an instantaneous and permanent record of blood flow patterns in the heart. (auth)

28331 MNOGOKANAL'NYE ANALIZATORY YADERNOI FIZIKI. IZDANIE VTOROE, PERERABOTANNOE. (Multichannel Analyzer in Nuclear Physics. Second Edition, Revised). Matalin, L. A.; Chubarov, S. I.; Ivanov, A. A. Moscow, Atomizdat, 1967. 357p.

Multichannel amplitude and time analyzers are examined. The requirements on such devices, illustrated by concrete examples, are discussed. The methods of construction and the design calculations are given. Multichannel analyzers of high precision and nanosecond response are examined. (J.S.R.)

28332 INSTRUMENTATION FOR SODIUM CIRCUITS. Cambillard, E.; Lions, N. (CEN, Fontenay-aux-Roses, France. CEN, Cadarache, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/6, 18p. (In French). (CONF-661110-16). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

Electromagnetic flow meters, level gauges and differential pressure gauges are among the main measurement instruments designed and tested for sodium reactors. The main characteristics of the flow meters used with Rapsodie are indicated. The instruments used in this connection are of the permanent-magnet or electromagnet type (in the primary circuits). A description is given of the calibration methods employed (use is made of diaphragms or Venturi tubes as standard flow meters) and information is given on the results measured for maximum sodium flows of 400 m^3/h. Three types of continuous level gauges were studied: resistance, induction, and ultrasonic gauges. (B.G.D.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 29343, 29348, 29370–29380, and 29387.

28333 (BNWL-SA-1101S) RADIATION INDUCED CHARGE MIGRATION IN MOS-FET TRANSISTORS. Philipp, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Lauritzen, P. O. (Washington Univ., Seattle). Feb. 10, 1967. Contract AT(45-1)-1830. 11p. (CONF-670708-1). Dep. CFSTI.

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio.

The response of insulated-gate field-effect transistors (MOS-FET) to ^{60}Co irradiation was studied as the devices were operating in a common source mode. (B.G.D.)

28334 THE EFFECTS OF γ-RAYS ON THE CHARACTERISTICS OF ORGANIC SCINTILLATORS. Klein, J.; Gresset, J.; Heisel, F.; Laustriat, G. (Centre de Recherches Nucleaires,

Strasbourg). Int. J. Appl. Radiat. Isotop., 18: 399-406(1967). (In French).

The influence of increasing doses of γ rays on luminescence yield, absorption and emission spectra of various organic scintillators was examined. It is shown that the stability of these characteristics is very dependent on the composition of the medium, and decreases in the order: liquids, plastics, crystals. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 28413, 28429, 28453, 28625, 28654, 28673, and 28698.

28335 (AEC-C-04-27) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. STRAHLENWIRKUNG AUF LEBENDES GEWEBE UND ORGANISMEN. (Bibliographies in Nuclear Science and Technology. Radiation Effects on Living Tissues and Organisms). Stahlhofen, W. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Feb. 1967. 125p. (In German and English). Dep.

A bibliography on the effects of radiation on living tissues and organisms is presented. It includes items published as conference reports, dissertations, and journal articles. (B.H.S.)

28336 (AEEW-R-493) USE OF ULTRASONICS TO INVESTIGATE SOFT TISSUE THICKNESSES ON THE HUMAN CHEST. Ramsden, D.; Peabody, C. O.; Speight, R. G. (Atomic Energy Establishment, Winfrith (England)). Mar. 1967. 18p. Dep. CFSTI. UK 2s. 6d.

The measurement of soft tissue thicknesses over the chests of nineteen male subjects using an ultrasonic probe is described. The apparatus and techniques are briefly described. The results are tabulated, and correlations of the mean soft tissue thicknesses with various combinations of body parameters are given. Variations in the distribution and amount of soft tissue between the chests of individuals mean that large corrections must be applied to results obtained from in vivo estimation of ^{239}Pu and ^{241}Am in the human lung. The best correlations obtained enable the mean soft tissue thickness to be predicted to within 0.2 cm (95% confidence limit) from a knowledge of the individuals weight, height and chest circumference. The corresponding error in an estimation of ^{239}Pu in the lung would be ±20%. (UK)

28337 (BNL-11358) BASIC PHYSICAL MECHANISMS IN RADIOBIOLOGY. Robertson, J. S. (Brookhaven National Lab., Upton, N. Y.). [nd]. 18p. (CONF-670305-3). Dep. CFSTI.

From Symposium on Biological Interpretation of Dose from Acceleration Produced Radiation, Berkeley, Calif.

Basic physicochemical mechanisms involved in the interaction between ionizing radiation and the absorbing material are reviewed. Analysis of ionization and excitation, heavy charged particles, sorption of energy of lighter charged particles (electrons, positrons, and mesons), electromagnetic radiations, and neutrons provides an explanation of differences in track densities. Relative biological effectiveness is associated with these differences, with the denser tracks in general giving the higher RBE's. Other factors influencing RBE are free radical diffusion rates, the oxygen effect, target theory, and the sensitivity of the irradiated system. Various forms of the hit theory are used to interpret LET-dependent variations in survival curves for cells. (H.G.D.)

28338 (BNWL-353(Rev.)) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, OCTOBER 1966, ON AEC DIVISION OF BIOLOGY AND MEDICINE PROGRAMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Research is reported on: factors affecting toxicity and metabolism of radionuclides in rats and aquatic organisms; lipid metabolism in lungs of x-irradiated rats; ^{239}Pu content of dogs after inhalation of $^{239}PuO_2$; in vitro uptake of ^{131}I by thyroid glands from rats; ^{238}Pu metabolism in dogs and pigs and in leaves of begonia and African violets; absorption and retention of chelated Pu in rats; inhibition of tryptophan synthetase activity in Neurospora crassa; characterization of radioinduced free radical reactions in aqueous systems; ^{137}Cs in the Eskimo food chain; harvest yield of Russian thistle and cheatgrass; analysis of the short-term movements of a darkling beetle Pelecyphorus sp.; ^{51}Cr, ^{65}Zn, and ^{59}Fe concentrations in plankton, periphyton, caddis fly larvae, and shiners from the Columbia River; temperature effects on metabolism of acetate in trout livers in vitro; earth sciences studies including development of the Functional Evaluation computer program; radioactive fallout rates and mechanisms in the Olympic National Park; washout coefficients for Cs in rain from the 1965-66 Rimrock test; prediction of the plume's centerline over Vanderberg AFB (Operation Mountain Iron); physical chemistry of ocean solutions; radiological and health physics; radiation detection and measurement instruments; and radiological chemistry. (H.G.D.)

28339 (BNWL-423) PLUTONIUM ABSTRACTS. Volume 7, Number 3. Russell, Barbara G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 31, 1967. Contract AT(45-1)-1830. 40p. Dep. CFSTI.

Seventy-two abstracts are presented on current literature on new developments in Pu technology in the fields of biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and reactor technology. (C.H.)

28340 (BNWL-SA-1145) SODIUM, WATER, AND B_{12} ABSORPTION IN IRRADIATED RATS: INFLUENCE OF BILE. Sullivan, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 20p. (CONF-660917-9). Dep. CFSTI.

From Gastrointestinal Radiation Injury Symposium, Richland, Wash.

The functional capacity of both the small and large intestine of rats was measured in situ to determine the effect of a near-lethal, 1000 R, and a supra-lethal, 1500 R, dose of x rays on ^{3}H and ^{22}Na transport. Although radiation did drastically reduce transport from lumen to blood, a reduction also occurred in blood to lumen movement. Measurement of net transport for the whole intestine indicated that, after radiation, sodium was moving into the lumen, and that decreased insorption from the large intestine was largely responsible for this deficit. An unexpected influence of bile on water and sodium was shown that may indicate a previously undescribed function of bile salts on intestinal transport. The absorption decrease in the small intestine, caused by the absence of bile, was greater than that resulting from exposure to 1000 R. These results indicate that transport information obtained by measuring function in gut segments from which bile has been excluded for some time by ligation or cannulation of the bile duct, may be misleading. (auth)

28341 (BNWL-SA-1254) RADIONUCLIDE CYCLING BY PERIPHYTON: AN APPARATUS FOR CONTINUOUS IN SITU MEASUREMENTS AND INITIAL DATA ON ^{65}Zn CYCLING. Cushing, C. E.; Porter, N. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 8, 1967. Contract AT(45-1)-1830. 18p. (CONF-670503-6). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

A system is described which permits the continuous measurement of uptake and cycling of radionuclides between stream periphyton and a controlled aqueous environment. The system was designed to avoid inherent difficulties in aquaria studies, i.e., the necessity of destroying or sub-sampling the community for each sequential analysis, the lack of a continuous flow of water over the algae to simulate stream conditions, and the inability to maintain a fixed ambient radionuclide concentration because of immediate uptake and recycling by the organisms. The apparatus permits evaluation of the effects of individual physical and chemical environmental factors in either an open one-pass system or in a closed recirculating system. Preliminary results of six uptake and two retention experiments using ^{65}Zn in the closed system are presented. (auth)

28342 (BNWL-SA-1258) MODELING THE BEHAVIOR OF RADIONUCLIDES IN SOME NATURAL SYSTEMS. Eberhardt, L. L.; Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 12, 1967. Contract AT(45-1)-1830. 20p. (CONF-670503-7). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Advantages and limitations of various models for uptake and retention of radioisotopes in natural systems are discussed in relation to process models, i.e., those in which the variability arises in the actual working of the system considered. Types of models evaluated are: linear differential equations with coefficients as functions of time, stochastic models, combination models, and linear differential equations with variable coefficients. Dependency of body burdens on excretion rates, body size, and extent of food chain contamination is recognized. Coefficients of variation for ^{137}Cs in plants and animals in the Northwest are tabulated. (H.G.D.)

28343 (CEA-R-2979) DETERMINATION DES REGIMES ALIMENTAIRES DES POPULATIONS DE ONZE REGIONS DE LA COMMUNAUTE EUROPEENNE EN VUE DE L'ETUDE DES NIVEAUX DE CONTAMINATION RADIOACTIVE: METHODOLOGIE. RESULTATS DES ENQUETES FAMILIALES. (Determi-

nation of the Diets in Eleven Regions of the European Community with a View to Studying the Radioactive Contamination Level: Methods Used. Results of Family Enquiries). Cresta, Massimo; Lacourly, Guy (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 1966. 296p. (In French). (EUR-2768.f). Dep.

The first results of diet studies made during the period 1963-1965 involving 9,000 families living in eleven different regions in six European countries are reported. The partial analysis of the data obtained covers a reduced sample of 3,725 families and makes it possible to establish the composition of the mean individual, monthly, and annual food consumptions for each of the eleven regions. Details of the organization of the survey, the data processing methods, and the presentation methods for the results are given in the first part of the report. The second part presents, in the form of numerical tables, the consumption of various foods and diet composition for each region. Summary tables make possible a comparison of the mean individual diets in the various regions studied. (tr-auth)

28344 (NP-16452) EFFECTS OF IONIZING RADIATION ON THE METABOLISM OF DNA IN CULTIVATED MAMMALIAN CELLS. Smets, Louis Antoon (Nijmegen Univ. (Netherlands)). 1965. 88p. Dep.

Thesis.

The effects of x irradiation on DNA metabolism were studied in monolayer cultures of fetal calf liver. Irradiation affected the asynchrony of the log phase cells in such a manner that the percentage of cells in the S phase, which normally remained essentially constant, became inconstant. Exposure to 1000 R reduced the frequency of dividing cells. However, the occurrence of a similar depression in mitotic activity was noted in sham-irradiated cells. Radioinduced reduction in the uptake of thymidine by DNA was attributed mainly to competitive inhibition in the uptake of exogenous thymidine. The rate of incorporation of ^{32}P into DNA after irradiation was studied at different extracellular concentrations of ^{32}P. It was concluded that x irradiation retards the uptake of exogenous phosphate into the DNA in a manner comparable to that of the radioinduced reduction in thymidine incorporation. (H.G.D.)

28345 (UCB-34P136-1) RADIATION STUDIES ON MEMBRANE TRANSPORT PROCESSES AND ASSOCIATED ENZYMES. Progress Report, May 1, 1966-April 30, 1967. Macey, Robert I. (California Univ., Berkeley. Dept. of Physiology). Contract AT(11-1)-34. 9p. Dep. CFSTI.

Progress is reported on studies on the effects of radiation on membrane transport processes in intact erythrocytes and membranes of dried erythrocyte ghost cells. Data are included on the effects of 7.5 MeV electrons at doses ranging from 0.1 to 30 Megarads on the inactivation of ATPase in dried membranes. (C.H.)

28346 (UCRL-70351) X-RAY FLUORESCENCE ANALYSIS APPLIED TO BIOLOGICAL PROBLEMS. Anspaugh, Lynn R.; Gofman, John W.; Lowe, Ora A.; Martin, Walter H. (California Univ., Livermore. Lawrence Radiation Lab.). May 1, 1967. Contract W-7405-eng-48. 21p. (CONF-670321-1). Dep. CFSTI.

From 2nd Symposium on Low Energy X- and Gamma Ray Sources and Applications, Austin, Tex.

X-ray fluorescence was used for the analysis of 66 elements in human fluids and tissues. Values for the occurrence of S, Cl, K, Ca, Fe, Cu, Zn, and Br in the serum of 39 ostensibly healthy males are tabulated. The remaining 57 elements occur at levels at 0.6 ppm or below, thus making quantitation inaccurate. Bromine had the highest concentration of any element above atomic number 20, and was consistently found in samples of brain and liver as well as serum. The possibility that disease states may be caused by abnormalities of homeostatic control mechanisms for various elements was studied in patients with mongolism, alcoholism, schizophrenia, and diabetes. Alterations in S, K, and Ca were found in all four disease categories. Elemental analyses were performed on samples of brain tissues from persons hospitalized for mental retardation. It is pointed out that most of the individuals hospitalized for mental retardation do not have a presently recognizable organic disease. Both Mn and Fe occurred at extremely high levels in the parietal region of the brain in comparison to serum levels. Brain iron concentration was found to be strongly correlated with age and was the only one of the elements measured that was age-dependent. (H.G.D.)

28347 (USNRDL-TR-67-30) URINARY EXCRETION OF DEOXYCYTIDINE: A POTENTIAL BIOCHEMICAL RADIATION DOSIMETER. Guri, C. D.; Swingle, K. F.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Mar. 27, 1967. 21p. Dep.

Rats were exposed to various doses of whole-body x rays, from 10 R to 400 R, and 24-hour urinary deoxycytidine (CdR) excretion determined by combined ion exchange and paper chromatographic methods. The baseline 24-hour urinary CdR excretion (nonirradiated rats) was 86.6 ± 13.9 μg; while after exposure to 28 R and 223 R, a significant increase of 70% and 260%, respectively, was observed. The highest rate of CdR excretion occurred during the first 4 hours postirradiation, and returned to baseline levels by the second day. A linear dose-response relationship was found for 24-hour CdR excretion at radiation doses over the range of 10 R to 223 R. For a given radiation dose, CdR excretion was considerably lower in rats previously splenectomized; thus, at 100 R the spleen appeared to contribute 82% of the excreted CdR. Age of the rats was an important determinant of CdR excretion: after exposure to 100 R, 5-week old rats showed a 312% increase in 24-hour urinary CdR content over that of nonirradiated age controls; for 12-week old animals the increase was 123%; while in 14-month old rats, the increment was only 47%. The biochemical origin of the excreted CdR as a degradation product derived from the polydeoxyribonucleotides, previously showed to be released in spleen and thymus at early times after irradiation, is suggested. It is concluded that urinary CdR excretion may be potentially useful as a biochemical index of radiation exposure. (auth)

28348 THE PHOTOOXIDATION OF THE PEPTIDE GROUP. I. FIBROUS PROTEINS. Meybeck, A.; Meybeck, J. (Ecole Superieure de Chimie, Mulhouse, France). Photochem. Photobiol., 6: 355-63(May 1967). (In French).

The determination of the α-keto, glyoxylic, and pyruvic acids in partial hydrolysates of fibrous proteins (keratin and fibrin) after exposure to uv light provided an hypothesis for a photooxidation mechanism for the α-amino acid residues of glycine and alanine in proteins. The primary reaction is believed to be the formation of the peptide radical $-NH-\dot{C}R-CO-$, and the breakdown of polypeptide chains is explained by the formation of α-ketoacyl peptide linkages. It was shown that glycine is more reactive than alanine to uv radiation, and this was confirmed by electron paramagnetic resonance studies, since the signal corresponding to the glycine type peptide radical always appeared in irradiated proteins. (BBB)

28349 STUDIES ON LIGHT-DEPENDENT CAROTENOID SYNTHESIS. I. THE ACTION SPECTRUM OF FUSARIUM AQUAEDUCTUUM. Rau, W. (Univ., Munich). Planta, 72: 14-28(1967). (In German).

The effective wavelengths over the uv and visible range for photoinduction were studied in an attempt to define the photoreceptor responsible for light-dependent carotenoid synthesis. Monochromatic light over the range 350 to 510 nm was used. Preliminary to determination of the spectrum, the optimal conditions for the light-dependent synthesis of pigments were studied. From these action spectra carotenoids can be ruled out as possible photoreceptors. The spectrum resembles the absorption spectra of certain flavoproteins, suggesting that a flavoprotein is the acting photoreceptor. Data of other investigators with different organisms support this conclusion. The action spectrum presented also resembles the spectra of phototropism in Phycomyces sporangiophores and Avena coleoptiles; therefore, the possibility is discussed that the same photoreceptor might be acting in all cases in which development and movements are mediated by light of short wavelength. (TSS)

28350 INFLUENCE OF IONIZING RADIATIONS ON THE METABOLISM OF LIVER GLYCOGEN. Bonsignore, D.; Canonica, C.; Lenzerini, L. (Centro Nucleare di S. Piero a Grado, Pisa, Italy). Ital. J. Biochem., 14: 1-38 (Jan.-Feb. 1965).

Wistar rats were exposed to 700-R, whole-body doses of x rays and a study was made of liver glycogen levels and enzyme activities. Determinations were made at 12, 24, 48, 72, 96, 120, and 144 hr postirradiation. After irradiation, liver glycogen levels of starved rats fell less sharply in comparison to that of control levels and at 48 hr was 50% of the basal level as compared to 15% in controls. In animals that were fed, the glycogen level was 90% of normal in irradiated animals as compared to 10% in controls. Activities of hexokinase, phosphoglucomutase, and glycogen synthetase from the liver were not affected by x-irradiation. Activity of polysaccharide phosphorylase decreased and that of uridine-diphosphoglucose pyrophosphorylase increased. It was concluded that the higher glycogen levels in irradiated animals as compared with control animals was in part the result of inhibition of enzymes involved in glycogen degradation and in part to the increase in activity of enzymes leading to glycogen synthesis. (BBB)

28351 LIPID FRACTIONS IN IRRADIATED RATS MAINTAINED ON VARIOUS DIETS. Nemec, Rudolf; Eichnerova-Laginova, Viera (Inst. of Oncology, Bratislava). Biologia, 20: 280-6(1965). (In Czech).

Several indicators of fat metabolism were studied in rats maintained on natural or synthetic diets after single whole-body irra-

diation with 600 R. Lipid levels were determined in serum, liver, and epididymal fat 2, 4, and 6 days postirradiation. Marked changes were seen in the lipid levels, particularly in phospholipids. The greatest change was observed in the iodine content of the serum and epididymal fat (decreased) and of the liver (increased). The results observed probably involved the formation of unsaturated fatty acids, and increasing unsaturation of other lipid substances, which then reacted with iodine. There were no significant differences in the effects of the diets themselves. (BBB)

28352 FUNCTIONAL ASSESSMENT OF THE CAPSULE OF NODULAR GOITER BY DATA OF RADIOINDICATION. Anikandrov, B. B.; Bykhovskaya, A. M. Med. Radiol., 12: No. 4, 36-40(Apr. 1967). (In Russian).

A method for topical radiometry of goiters, different in structure and function, removed during the operation and investigated histotopographically is given. The high sensitivity of the apparatus employed made it possible to use minimal quantities of radioiodine. The authors disclosed a significant absorption of radioiodine by the capsule of nodular goiter, in the majority of goiters studied its activity exceeded that of the goiter tissue. Confrontation of the activity of different areas of thyroid tissue gives ground to suppose the special "barrier" role of the capsule. The paradoxical fact of radioiodine accumulation in the latter could partially be explained by the presence of intracapsular follicles and, possibly, extrafollicular accumulation of the isotope. (tr-auth)

28353 UPTAKE AND RETENTION OF ^{65}Zn FROM CERTAIN FOODS. Honstead, J. F. (Battelle Memorial Inst., Richland, Wash.); Hildebrandt, P. W. Contract AT(45-1)-1830. Health Phys., 13: 649-52(June 1967).

Zinc-65 is one of the radionuclides formed by neutron activation in the cooling water circulated through the Hanford reactors. The 245-day half-life of this nuclide is long enough for it to persist in the river all the way to the coast and to enter the food chain of shellfish and other sea organisms which concentrate zinc. An experiment was conducted in which one of the authors ate fresh oysters collected from the Washington coast, and his uptake and retention of ^{65}Zn from the oysters determined by whole-body counting. The oysters were analyzed for ^{65}Zn before consumption, permitting quantitative evaluation of the appropriate metabolic parameters. The results indicate an average fractional zinc absorption of 13.5 per cent for this individual. The ^{65}Zn persisted in his body with an effective half-life (including both biological elimination and radioactive decay) of about 100 days. The highest body burden of ^{65}Zn attained during the course of this experiment was 40 nCi and occurred after eighty-one meals of oysters eaten in a period of 570 days. The recommendation of the International Commission on Radiological Protection for the sustained (lifetime) body burden of an individual is not exceeding 6000 nCi of ^{65}Zn. (UK)

28354 INTERPRETATION OF LEVELS OF ^{90}Sr IN HUMAN BONE. Fletcher, W. (United Kingdom Atomic Energy Authority, Chester, Eng.); Loutit, J. F.; Papworth, D. G. Brit. Med. J., 2: 1225-30(Nov. 19, 1966).

New data on ^{90}Sr in bone, derived since the considerable increase in fallout following the 1961-2 nuclear-weapon detonations in the atmosphere, are reported. The results for 1962-4 reflected the increase of contamination of food following the massive testing of nuclear weapons in 1961-2. Maximum concentrations within any one yr continued to occur in infants around 1 yr old, and this max was reached at about 4 months of age. The individual values in infants varied widely, but the general levels in the wetter areas, Wales and Scotland, were slightly higher than in the Midlands and Southeast England. In children and adolescents, values were lower and much less variable between individuals and domicile. In contrast with adults, many of whose bones, for example, vertebrae, showed substantially higher concentrations than others, there was little variation within the skeleton in children and even adolescents. It is thus possible in juveniles to take the concentrations of ^{90}Sr observed in one bone as representative of the whole skeleton, and thus to derive body burdens according to age and year. With further data on observed contamination of diet it was calculated that the fractional loss of the ^{90}Sr body burden each year is about 0.5 until the age of 8, falling to 0.1-0.2 in adolescence. It was further calculated that the fractional retention of dietary ^{90}Sr is about 0.07 each year throughout childhood and adolescence. (BBB)

28355 BEHAVIOR OF STRONTIUM AND CALCIUM IN THE RICE PLANT. Sakaguchi, Takashi (Univ. of Miyazaki, Japan). Nippon Dojo-Hiryogaku Zasshi, 35: 203-5(1964). (In Japanese).

The absorption and distribution of ^{89}Sr and ^{45}Ca in the rice plant was studied by the double-labeling method. Young rice plants (1-½ month old) were placed in a culture medium containing 24 μC ^{89}Sr and 40 μC ^{45}Ca for 7 days. After this treatment with radioisotopes the plants were collected and the distributions of ^{89}Sr and ^{45}Ca were analyzed. The average discrimination factor of ^{89}Sr over ^{45}Ca for the whole plant was 0.9-1.1, with no differential absorption between 2 elements being observed. Most absorbed ^{89}Sr and ^{45}Ca were accumulated in the stem and leaves; less uptake on the seeds was observed. Autoradiographic analysis of isotope distribution during maturation showed that most of the ^{89}Sr was distributed in lower parts of the leaves. Both elements moved from the root to other organs within 7 days after the treatment with radioisotopes. The discrimination factor of roots was higher than that of other organs and ^{89}Sr was retained longer in roots than ^{45}Ca. No difference in distribution between the 2 elements was observed in stem leaves and faded leaves. The discrimination factor of seeds was lower than that of other organs. The ^{89}Sr content of seeds was lower than that of ^{45}Ca. The discrimination factor for ^{89}Sr, in various parts of rice plants was: for the whole plants 0.9-1.1, roots 1.2-1.9, faded leaves 0.9-1.2, stem leaves 0.8-1.2, and brown rice 0.6-0.7. (BBB)

28356 EFFECTS OF γ IRRADIATION UPON MILK AND MILK PROTEINS. PART I. CHANGES IN PHYSICO-CHEMICAL PROPERTIES OF WHOLE CASEIN AFTER γ IRRADIATION AND ITS EFFECTS ON LACTOSE-CONTAINING WHOLE CASEIN SOLUTIONS. Umemoto, Yaichiro; Ito, Hideo; Sato, Yasushi (Nagoya Univ., Japan). Nippon Nogei Kagaku Kaishi, 40: 271-6(1966). (In Japanese).

The effects of 1- to 5-Mrad ^{60}Co radiation on a 1% solution of casein (designated solution S-I) and 1% casein solution containing 1% lactose (S-II) were studied. Relative viscosity of S-I increased with increasing radiation doses up to 3 Mrad, and decreased at 5 Mrad. In S-II, it gradually decreased with increase in dose up to 5 Mrad. A single peak was seen in moving boundary electrophoresis of S-I irradiated at 2 and 5 Mrad. The relative mobility decreased slightly. In S-II, α and β peaks appeared at 2 Mrad, and a single peak was seen at 5 Mrad. Only a single peak appeared in sedimentation patterns of S-I and S-II. The sedimentation coefficients became larger with increasing radiation doses, and at 5 Mrad they were 2.5- to 2.8-fold those of nonirradiated S-I. The coefficients of S-I were larger than S-II. Ultraviolet absorption maxima of S-I and S-II shifted only slightly after irradiation, although absorbances increased with increasing radiation doses, particularly at 5 Mrad. Difference spectra of S-I and S-II were determined, using nonirradiated S-I as the reference solution. At 2 Mrad, their spectra indicated slightly negative absorbances in the range of 270 to 290 mμ, and positive absorbances at 290 to 330 mμ. At 5 Mrad highly positive absorbances were detected at 260 to 330 mμ. (BBB)

28357 LEACHING OF METABOLITES FROM ABOVE-GROUND PLANT PARTS AND ITS IMPLICATIONS. Tukey, H. B. Jr. (Cornell Univ., Ithaca, N. Y.). Bull. Torrey Bot. Club, 93: 385-401(Nov.-Dec. 1966).

A review is presented on studies relating to the leaching of ^{45}Ca, ^{89}Sr, ^{86}Rb, ^{32}P, ^{35}S, and other inorganic ions, and ^{14}C-labeled organic metabolites from the foliage of plants. Large quantities of both organic and inorganic metabolites may be leached from a great diversity of plants by rain, dew, and mist. The leaching of inorganic cations apparently involves diffusion and exchange reactions with the leaching solutions on the leaf surface. Thus, when bean plants containing root-absorbed ^{45}Ca and ^{86}Rb were treated with a metabolic inhibitor, 2,4-dinitrophenol, to reduce the energy level within the plants, loss of both radioisotopes by leaching was similar from treated and untreated plants. Similarly, after the carbohydrate level of bean plants was depleted by growing them in complete darkness, losses of ^{45}Ca and ^{86}Rb were no different than after plants were grown in natural light. Similar results were found with ^{89}Sr. Carbohydrates, ^{32}P, and ^{35}S apparently are leached by a similar, but somewhat different mechanism. Metabolites leached from above-ground plant parts can be subsequently reabsorbed by roots and foliage of the same or different plants, and translocated to other plant parts. Such cycling of metabolites from plant to plant was demonstrated with inorganic cations such as ^{45}Ca and ^{89}Sr and anions such as ^{32}P which were leached from squash foliage and root-absorbed by several species, including both woody and herbaceous types. This recycling has important implications in plant nutrition, adaptation, distribution, and susceptibility to disease. (BBB)

28358 CALCIUM DEPLETION AND REPLETION IN LAYING HENS. I. EFFECT ON CALCIUM IN VARIOUS BONE SEGMENTS, IN EGG SHELLS AND IN BLOOD PLASMA, AND ON CALCIUM BALANCE. Hurwitz, S.; Bar, A. (Volcani Inst. of Agricultural Research, Rehovot, Israel). Poultry Sci., 45: 345-52(Mar. 1966).

The effect of Ca depletion and repletion on bone, egg shell, and plasma Ca, and on ^{45}Ca retention, was studied in 3 trials. The

dietary Ca depletion resulted in a progressive decrease in blood and egg shell ^{45}Ca. Both ends and the medullary segments of the femur were markedly depleted of Ca during Ca restriction, but the cortical segment was hardly affected. Substitution of gypsum for dietary limestone did not aggravate the Ca depletion significantly. Following a 5-day depletion with 1.7% Ca diets, egg shell Ca returned to normal after 6 to 8 days on a high Ca repletion regime. After 3 weeks on the repletion regime, the femurs completely recovered their Ca. A Ca balance experiment indicated that ^{45}Ca retention markedly increased after a 2-day feeding of a diet containing 0.12% Ca. This increase was apparent in hens receiving either 1.82 or 3.92% Ca during the periods preceding or following the Ca depletion. (BBB)

28359 INFLUENCE OF CALCIUM, POTASSIUM, AND STRONTIUM IONS ON THE ISOLATED RAT DUODENUM AS A FUNCTION OF THE TEMPERATURE OF THE MEDIUM. Quevauviller, Andre; Binet, Pierre; Braoude, Maurice (Faculte de Pharmacie, Paris). Therapie, 20: 165-72(Jan.–Feb. 1965). (In French).

Strips of rat duodenum were maintained in Tyrode's solution at 37°, and additions of various ions were tested. Spontaneous contractions diminished in amplitude when the temperature of the both was raised to 40° and disappeared at 43 to 44°. Addition of K ion increased the tonus and amplitude of contractions in muscle kept in a bath at 42°, and increased the temperature (to 47°) at which contractions ceased. Addition of Ca ion at 37° arrested all spontaneous contractile activity. A similar result was noted at higher temperatures. However, at low temperature, when contraction was diminished or ceased altogether, Ca ion addition stimulated contraction. When Sr ion was added to duodenum at 37°, contractility was stimulated, and at higher temperatures, up to 42°, Sr acted as K, but more intensely so. That is, it reinstituted contractions in muscle that had lost its tone and spontaneous contractility. However, at low temperatures, at which spontaneous activity had ceased, Sr had the same effect as Ca; i.e, contractions reappeared. (BBB)

28360 INDIRECT INACTIVATION OF DEOXYRIBONUCLEIC ACID. Kingdon, Kenneth H. J. Phys. Chem., 71: 1710-16(May 1967).

The concept that radiation inactivation of a DNA molecule is caused by the generation of a single pair of H radicals in a sugar, which migrate through the adjacent bases by a two-dimensional random walk, caused by excitation of the electron atmosphere of the molecule by the radiation which generated the H radicals is explored. The chance was estimated that this single pair of H radicals shall react with both members of an adjacent base pair, thus leading to the formation of a covalent cross-link between the bases and inactivation of the entire molecule is estimated. The chance was estimated to be 0.12, and from this and the experimental G value of 2.0 for producing the H radicals, the D_{37} for virus DNA was found to be 7.5×10^{12}/(molecular weight) rads, in fair agreement with experiments. A molecule of diploid cell DNA has much lower sensitivity to radiation than a molecule of equal mass of virus DNA. Part of this is due to the duplication of genes, but it was suggested that another factor was the existence of a three-dimensional secondary structure in the diploid DNA formed by H bonds with adsorbed water, in which the pair of H radicals was much more widely dispersed by a three-dimensional random walk and therefore was less effective for cross-linking the bases. An initial effect of radiation on a diploid cell was to break some of these water H bonds, giving isolated pieces of virus-like twin DNA helix, that were more sensitive to radiation. The production of isolated twin helix DNA by the radiation was estimated, and it was shown that a log-log plot of the fraction of diploid cells surviving at dose D, against cosh (D/D_{37}), should be linear, with a slope of −2.3. (auth)

28361 STUDIES ON THE INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. V. THE EFFECT OF ADMINISTRATION OF CALCIUM ALGINATE. Paul, T. M.; Skoryna, Stanley C.; Waldron-Edward, Deirdre (McGill Univ., Montreal). Can. Med. Ass. J., 95: 957-60(Nov. 5, 1966).

A method of selective suppression of absorption of radioactive strontium from ingested food material is described that allows calcium to be available to the body. In the present study the effects of administering calcium alginate were determined. Studies on the relative binding of Ca and Sr by calcium alginate in vivo were also important to the investigation of calcium-strontium exchange. Samples of calcium alginate were obtained commercially or prepared from sodium salts and the binding properties with ^{45}Ca and ^{89}Sr were tested in vivo. There was a free exchange of radioactive calcium as well as of strontium with bound inactive calcium. The amount of ^{45}Ca retained in the gut by calcium alginate was proportionally less than ^{89}Sr, so that the ratio $^{89}Sr/^{45}Ca$ in the bone was consistently and significantly lower in treated rats. Calcium alginate acted differently from other calcium salts, although in a manner similar to sodium alginate. (auth)

28362 ALTERATIONS IN ALBUMIN OF HARICOT SEED UNDER THE INFLUENCE OF GAMMA-RADIATION OF ^{60}Co. Vlasyuk, P. A.; Vitkalenko, L. P.; Nazarova, N. S.; Shkvaruk, R. M. (Inst. of Plant Physiology, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 4, 369-72(Apr. 1967). (In Ukrainian).

Globulins of haricot seeds of two varieties grown from seeds, irradiated in the doses of 1000, 5000, 7500, 10,000, 16,000 R were studied electrophoretically. The mobile change of electrophoretical fractions in variants with irradiation was noted as well as their number increase in M2 (stanislavskaya haricot) with the further restoration of fraction numbers in M3 and M4. The correlation of albumin fractions in the seed-lobes was changed under radiation influence. (auth)

28363 THE EFFECT OF ULTRAVIOLET LIGHT ON VITAMIN C CONTENT IN PEA SPROUTS AND OXIDATION ENZYME ACTIVITY. Gutmanis, K. (Inst. of Botanics, Riga). Latv. PSR Zinat. Akad. Vestis, No. 2, 100-3(1967). (In Latvian).

When pea seeds were irradiated prior to soaking with ultraviolet light 1, 2 or 4 hrs, the vitamin C content in them at sprouting was increased by 10 to 40 percent. In vitamin C content modifications oxidation enzymes, ascorbic acid oxidase, polyphenol oxidase, and peroxidase were of considerable importance. (auth)

28364 DIFFERENCES IN BARIUM AND STRONTIUM METABOLISM IN LIGHT OF THE THEORY OF ALKALINE-EARTH METABOLISM /MARSHALL/. Domanski, T. M.; Depczyk, D.; Liniecki, J. (Inst. of Occupational Medicine, Lodz, Poland). pp 95-100 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

Whole-body retention of ^{85}Sr and ^{133}Ba and tracer:calcium ratio of the serum in adult rats were measured after single administration of the isotopes. Results were compared with predictions based upon the theory of alkaline earth metabolism, as developed by Marshall. Good agreement between theory and experiment was found for strontium whereas substantial discrepancy was observed for barium. Reasons are discussed and hypothetical explanations are presented. (auth)

28365 ANESTHESIA. LXXII. ANESTHESIA WITH DEUTEROCHLOROFORM. Krantz, John C. Jr.; Koski, Walter S.; Loecher, Claire K. (Johns Hopkins Univ., Baltimore, Md.). Biochem. Pharmacol., 16: 603-4(Mar. 1967).

Deuterated chloroform was used to determine the character of the anesthetic syndrome that $CHCl_3$ elicits: whether or not deuterium was exchanged for hydrogen during anesthesia and whether deuterochloroform ($CDCl_3$) sensitized the heart to epinephrine as does chloroform. The deuterated chloroform had an isotope purity better than 99.5 atom %. Swiss-Webster albino mice and mongrel dogs were anesthetized. Mice responded to the anesthetic action of $CDCl_3$ as they responded to $CHCl_3$. The anesthetic syndromes were similar quantitatively and qualitatively. To examine D-H exchange, the exhaled vapors of the mice were subjected to mass spectrometric analysis. The exhaled deuterated chloroform had the same isotopic content as the $CDCl_3$ before use that indicated the absence of hydrogen exchange. The anesthetic syndromes in dogs resulting from $CHCl_3$ and $CDCl_3$ also appeared to be essentially the same. However, $CDCl_3$ was slightly more potent, since 20% more $CHCl_3$ was necessary to achieve apparently the same stage of anesthesia in the same dogs. As with $CHCl_3$, epinephrine injection during $CDCl_3$ anesthesia produced marked arrhythmias in all animals. Thus, deuterochloroform caused an anesthetic syndrome similar to that of chloroform; D did not exchange with tissue constituents for H during anesthesia with $CDCl_3$; and deuterochloroform sensitized the heart of the dog to challenging doses of epinephrine. (BBB)

28366 CALCIUM DEPLETION AND REPLETION IN LAYING HENS. II. THE EFFECT ON RADIOCALCIUM AND RADIOSTRONTIUM RETENTION IN BONE AND DEPOSITION IN THE EGG SHELL. Hurwitz, S.; Bar, A. (Volcani Inst. of Agricultural Research, Rehovot, Israel). Poultry Sci., 45: 352-8(Mar. 1966).

The deposition of ^{45}Ca and ^{85}Sr in the egg shell and their retention in the blood plasma and femur, as influenced by dietary Ca level and source, was studied in two trials. Following a single dose of ^{45}Ca, hens on a low-Ca diet (1.8%) deposited more Ca in their egg shells as compared to controls fed 3.5% Ca. They retained more ^{45}Ca in their plasma and bone after 4 hours, but less after 1 week. A severe Ca restriction applied 24 hrs after dosing resulted in an increased deposition of ^{45}Ca in the egg shell and a marked decrease in the retention of the isotope in blood plasma and bone. Similar results were obtained for both ^{45}Ca and ^{85}Sr, in a second trial where the dietary treatments were given in a factorial design of two dietary Ca levels (3.7% and 1.7%) and two Ca

supplements (limestone and gypsum). The dietary treatments were started 24 hrs after dosing. Dietary Ca depletion significantly increased the shell deposition, but reduced the bone retention of the radioisotopes. There was no significant effect of the Ca source on the deposition and retention of the radioisotopes. The $^{85}Sr/^{45}Ca$ ratio in the egg shells appeared to be influenced by dietary gypsum but not by the Ca level. It was concluded that low-Ca diets fed at the time of dosing favor a greater retention of ^{45}Ca soon after dosing. However, due to extensive bone resorption, such a treatment results in a greater depletion of the isotope from bone during the following days. It is suggested that in the laying hen an efficient method to reduce the body burden of bone-seeking radioisotopes is to feed a high-Ca diet during contamination and a low-Ca diet for a short period after contamination. (BBB)

28367 YIELD COMPONENTS IN BEANS, AS AFFECTED BY INTERCROSSING AND NEUTRON IRRADIATION. Pinchinat, Antonio M.; Adams, M. W. (Michigan State Univ., East Lansing). Turrialba, 16: 247-52(July-Sept. 1966).

Results are reported on the response of some plant traits to recurrent intercrossing and neutron irradiation, alone or combined. Ten homozygous lines of white navy beans, which differed in many agronomic traits, were crossed in all possible ways, and half of the seed of parents and intercrosses received a dose of fast neutrons (1 to 2 MeV) equivalent to about 739 rep. The other half served as a control. With 1 or 2 cycles of recurrent intercrossing, with or without neutron irradiation, substantial gains in selection for high yield and yield components were possible, through the induction of a large increase in variability and means. The neutron treatment in itself was not effective in this respect. A few grossly stunted and malformed plants, invariably sterile, were attributable to neutron treatment. The failure of the irradiation treatment to have any noticeable effect on the yield characteristics and their interrelation was not surprising since the critical x-ray dose for beans is about 10,000 R, or over 10 times the dose used in this experiment. To guarantee a 70 to 80% seedling emergence, 739 rep of neutron radiation, was judged a safe limit. (BBB)

28368 METABOLISM OF RADIOACTIVE ZINC IN THE LIVER DAMAGED WITH CARBON TETRACHLORIDE. III. STUDIES AT THE SUBCELLULAR LEVEL. Wysocki, Kazimierz (Medical Academy, Poznan, Poland); Hansz, Janusz; Owczarek, Lucjan; Fenrych, Wladyslaw; Gorski, Szczesny; Majewski, Czeslaw. Acta Med. Pol., 7: 253-6(1966).

Distribution of radiozinc in various cell fractions of rat liver was studied 16, 24, and 36 hr after subcutaneous injection of μCi $^{65}ZnCl_2$. In some rats, liver injury was produced by carbon tetrachloride poisoning. In the control group, highest radioactivity was found in the mitochondrial and nuclear fractions, and much lower activity in the microsomal fraction and supernatant. In the three consecutive periods a marked drop in activity was observed in the mitochondrial fraction and a slight drop in the microsomal fraction; a slight rise occurred in the nuclear fraction. In animals injected with carbon tetrachloride, radioactivity in the mitochondrial and nuclear fractions was also higher than in the other fractions, but lower than in the control group. Only after 36 hr were similar activities in the mitochondrial fractions of both groups of rats observed. A progressive drop in radioactivity was observed in the nuclear fraction, accompanied by a rise in ^{65}Zn in the supernatant. No significant differences in radioactivity between the mitochondrial and microsomal fractions were observed in the experimental rats in all 3 intervals. Marked accumulation of ^{65}Zn in the mitochondrial fraction and rapid drop in radioactivity in the healthy animals indicate normal mitochondrial function. Lower radioactivity in animals injected with carbon tetrachloride indicates damage to the cellular elements. (BBB)

28369 PROTOPORPHYRINEMIC LIGHT DERMATOSES. Ziegler, G. (Univ., Basel). Dermatologica, 133: 53-7(1966). (In German).

After irradiation of erythrocyte suspensions from patients with congenital erythropoietic porphyria, for 30 min with a Hg uv light source equipped with a blue fluorescence filter, the erythrocytes that had the greatest concentrations of porphyrins hemolyzed most frequently. Normal erythrocytes and protoporphyrin-rich erythrocytes from Pb-intoxicated patients did not hemolyze. These results indicate a disturbance in the equilibrium between protoporphyrinogen and protoporphyrin. Photohemolyses may be a general characteristic of erythropoietic porphyrias. Along with the hemolysis, there was elevated fecal excretion of protoporphyrins with normal urinary protoporphyrin levels. Hyperaminoaciduria and hyperaminoacidemia were also noted. In serum aspartic acid, glutamic acid, glycine, alanine, serine, and ornithine levels were elevated, and in urine aspartic acid, glutamic acid, glycine, histidine, hydroxyproline, and ornithine were elevated. The blood picture was otherwise normal, except in 2 cases where the serum Fe was increased to 180 and 250 mg %, respectively. (BBB)

28370 STUDY OF THE STIMULATION OF THE UPTAKE OF IODINE BY THE THYROID OF THE RAT AS AN EFFECT OF ADIPHENINE. Mornex, R.; Tourniaire, J.; Falconnet, M.-F.; Durand, H. (Faculte Mixte de Medecine et de Pharmacie, Lyon). Ann. Endocrinol. (Paris), 27: 484-9(1966). (In French).

The action of adiphenine (diethylaminoethyl ester of diphenyl acetic acid, Trasentine) on ^{131}I incorporation by the thyroid gland of female Wistar rats was studied. The 180- to 200-g rats were given subcutaneous injections of 2.5 mg adiphenine daily for 10 days before injection of ^{131}I. Propylthiouracil was added to the diet of some rats at a level of 0.1%. Adiphenine treatment produced a significant increase in ^{131}I uptake by the thyroid. Expressed as the thyroid/plasma ratio (radioactivity per 100 mg of gland/radioactivity per 0.1 ml of plasma) a 50% increase was noted (285 in controls vs 436 in treated rats). No additive effect of adiphenine with propylthiouracil was noted, and its effect was absent in hypophysectomized rats. Adiphenine increased thyroid ^{131}I uptake without affecting gland morphology or oxygen consumption. Urinary radioiodide excretion was decreased by the drug. Evidently it acts by stimulating pituitary thyrotropic activity. (BBB)

28371 EVALUATION OF RADIOCERIUM AS A NONABSORBED REFERENCE MATERIAL FOR DETERMINING GASTROINTESTINAL SITES OF NUTRIENT ABSORPTION AND EXCRETION IN CATTLE. Miller, J. K.; Perry, S. C.; Chandler, P. T.; Cragle, R. G. (Univ. of Tennessee, Oak Ridge). J. Dairy Sci., 50: 355-61(Mar. 1967).

A study was conducted in dairy cattle to evaluate radiocerium as a nonabsorbed reference material. Dry matter and daily administered ^{144}Ce were measured throughout the gastrointestinal tracts of animals ranging in age from young calves to mature cows. Daily fecal recovery of ^{144}Ce from 11 animals fed grain and hay averaged 97% of the daily dose after the fourth day. No pattern of diurnal variation in ^{144}Ce excretion was evident in fecal concentrations during successive 2-hr collections for 90 hr. The first measurable amounts of radiocerium appeared in fecal samples collected 10 hr after single doses, and maximum excretion occurred at between 20 and 40 hr. Similar results were obtained with simultaneously administered chromic oxide. Within-animal comparisons of ^{141}Ce given by capsule with ^{144}Ce previously mixed in the feed were made for both milk- and grain-fed calves. With grain-fed calves, no differences were detected in gastrointestinal distributions of radiocerium. However, with milk-fed calves, capsules containing ^{141}Ce went to the rumen, whereas milk containing the ^{144}Ce was directed to the abomasum. Over 90% of the radiocerium was adsorbed on to undigested residue, as indicated by ultracentrifugation or availability to cation exchange resin. (BBB)

28372 CARDIAC EXCITABILITY IN THE COURSE OF RADIATION DISEASE. II. Jurkovic, Vilo; Vokrouhlicky, Lubor (Charles Univ., Hradec Kralove, Czech.). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradec Kralove, 9: 731-5(1966).

It was shown earlier that ventricular fibrillation occurs when ventricular tachycardia is induced by aconitine nitrate after whole-body x irradiation. A study was made of this tendency toward ventricular fibrillation after whole-body irradiation and local irradiation of the heart or the head, and the incidence of arrhythmias and QRS changes after procaine block of vagosympathetic nerves of the neck. After whole-body irradiation with 1000 R, procaine lost its therapeutic and preventive antiarrhythmic effect and caused a profibrillatory effect. Similar results were obtained after 1000 R local irradiation of the heart or the head. Decreased therapeutic and preventive effects of procaine occurred with all routes of administration. The most striking results were observed after local irradiation of the head because the earliest conversion of tachycardia into ventricular fibrillation occurred. After bilateral block of the neck, vagosympathetic abnormalities of ECG and arrhythmias were seen in nonirradiated animals and after whole-body irradiation. No abnormalities were found after local irradiation of the heart and head. Irradiation of the head may make the heart susceptible to fibrillation after induction of ventricular tachycardia, because some irradiated cerebral centers which have an influence on the heart may enhance its excitability and render it more vulnerable during ventricular tachycardia. (BBB)

28373 RADIOACTIVE STRONTIUM CONTENT IN HUMAN DECIDUOUS TEETH. Santholzer, Vilem; Knaifl, Josef (Charles Univ., Hradec Kralove, Czech.). Sb. Ved. Praci. Lekar. Fak. Karlovy Univ., Hradec Kralove, 9: 359-62(1966). (In Czech.).

Radiostrontium (^{90}Sr) levels were determined in the deciduous teeth of children born between 1954 and 1961. The children were divided into 2 groups, aged 3 to 6 and 6 to 10 yr of age. The teeth were extracted in 1964. In the first group (3- to 6-yr-old children) the ^{90}Sr level was higher (2.9 pCi ^{90}Sr/g Ca) than in the older group 2.5 pCi ^{90}Sr/g Ca). In an adult (>20 yr old) control group the level was 1.4 pCi ^{90}Sr/g Ca. These values are comparable to those found in children's deciduous teeth in the United States and West Ger-

many. The method of assaying ^{90}Sr is described. Heating of the teeth at 800°C and pulverizing them was followed by addition of carrier Sr and dissolution of the sample in 65% nitric acid. The supernatant was treated with fuming nitric acid and the precipitated $Sr(NO_3)_2$ dissolved and reprecipitated to lower the Ca content. Strontium was then converted to the sulfate and counted in this form. (BBB)

28374 A DEOXYRIBONUCLEASE ACTIVITY SPECIFIC FOR ULTRAVIOLET-IRRADIATED DNA: A CHROMATOGRAPHIC ANALYSIS. Nakayama, Hiroaki; Okubo, Shunzo; Sekiguchi, Mutsuo; Takagi, Yasuyuki (Kyushu Univ., Fukuoka). Biochem. Biophys. Res. Commun., 27: 217-23(Apr. 20, 1967).

A chromatographic analysis of a crude extract of Micrococcus lysodeikticus demonstrated that at least two different fractions, A and B, were involved in the selective degradation of uv-irradiated DNA (i-DNA). The breakdown of DNA by the crude extract was followed by measurement of the release of radioactivity from ^{32}P-labeled DNA into the acid-soluble fraction of the reaction mixture employed with a windowless gas flow counter. The crude extract was observed to breakdown i-DNA more efficiently than non-irradiated DNA (ni-DNA). The crude extract was fractionated by TEAE-cellulose column chromatography. When assayed with heat-denatured DNA (hd-DNA), i-DNA, and ni-DNA as a substrate, the nuclease activity for each DNA was found as a single peak at the same position. Selective degradation was not observed with any of the fractions; i- and ni-DNA were degraded to almost the same extent by the peak fraction. Increased activity on i-DNA was recovered by chromatographic assay in the presence of an aliquot of the peak fraction; results revealed that the activity specific for i-DNA was clearly at the beginning of the chromatograph (fraction A). The fraction with nonspecific nuclease activity was near the end of the chromatogram (fraction B). The course of breakdown of i-DNA with either fraction A or B was very slight. The addition of fraction A to fraction B increased the breakdown of i-DNA but not of ni-DNA; the combination of fractions A and B was necessary for selective breakdown of i-DNA. Hd-DNA was more rapidly digested by fraction B than i- or ni-DNA and the addition of fraction A to fraction B did not enhance the breakdown of hd-DNA. The active principles in both fractions were nondialyzable and were inactivated by phenol; heating at 100°C completely destroyed the activity of fraction B and 75% of the activity of fraction A was destroyed. Selective inactivation of uv-irradiated transforming DNA (iT-DNA) also required the combination of both fractions. Magnesium ions were necessary for this reaction as well as for the breakdown of DNA. The transforming activity of ni-DNA was not affected by treatment under the conditions used. It was concluded that a component in fraction B seemed to be necessary for the release of acid-soluble materials from i-DNA preattacked by fraction A. Also, the component in fraction A was not active on the single-stranded region of DNA that is said to be produced by uv-irradiation; the inactivation of iT-DNA was brought about by a DNA-ase activity specific for i-DNA. (B.H.S.)

28375 A MUTANT OF MICROCOCCUS LYSODEIKTICUS DEFECTIVE IN A DEOXYRIBONUCLEASE ACTIVITY SPECIFIC FOR ULTRAVIOLET-IRRADIATED DNA. Okubo, Shunzo; Nakayama, Hiroaki; Sekiguchi, Mutuso; Takagi, Yasuyuki (Kyushu Univ., Fukuoka). Biochem. Biophys. Res. Commun., 27: 224-9 (Apr. 20, 1967).

The isolation and characterization of a Micrococcus lysodeikticus mutant defective in uv-irradiated DN-ase (UV-DNase) is described. The mutant had the same level of uv-sensitivity and ability to reactivate and propagate uv-irradiated phage as the wild type had. Irradiated transforming DNA of B. subtilis was inactivated by the crude extract of M. lysodeikticus wild type. When the mutant extract was used, almost all the transforming activity was retained. It was concluded that UV-DNase was not concerned with dark repair and that it would be a good starting material for fractionation and purification of the enzymes responsible for each step of dark repair. (B.H.S.)

28376 A NEW APPROACH TO THE STUDY OF THE MECHANISM OF BIOSYNTHESIS OF VITAMIN A FROM CAROTENE BY ACTIVATION OF OXYGEN ^{18}O AS A RESULT OF A NUCLEAR REACTION $^{18}O(\alpha,n\gamma)^{21}Ne$ BY MEANS OF α-PARTICLES ACCELERATED IN A CYCLOTRON. Vartapetyan, B. B.; Dmitrovskii, A. A.; Alkhazov, D. G.; Lemberg, I. Kh.; Girshin, A. B.; Gusinskii, G. M.; Starikova, N. A.; Erofeeva, N. N.; Bogdanova, I. P. (Inst. of Plant Physiology, Moscow. Inst. of Biochemistry, Moscow. Ioffe Inst. of Physics and Tech., Leningrad). Biochemistry (USSR) (Engl. Transl.), 31: 759-63(Sept.-Oct. 1966). Translated from Biokhimiya, 31: 881-6(Sept.-Oct. 1966).

To study the mechanism of biosynthesis of vitamin A from carotene in the body of rats with avitaminosis A, heavy oxygen ^{18}O was used (in the composition of the oxygen of the atmosphere and the oxygen of the water), with its subsequent activation by bombarding particles $^{18}O(\alpha,n\gamma)^{21}Ne$ accelerated in a cyclotron. The vitamin A preparation isolated from the rats' liver was found to contain heavy oxygen, derived from the molecular oxygen of the atmosphere ($^{18}O_2$). No direct incorporation of the water oxygen ($H_2{}^{18}O$) could be demonstrated in these circumstances. (auth)

28377 BEHAVIOUR OF NUCLEAR FATTY ACIDS OF PAN-IRRADIATED RAT LIVERS. Slaviero, G. E.; Pallavicini, E. Bobbio; Zanetti, A. (Univ., Pavia, Italy). Minerva Radiol., Fisioterap. Radiobiol., 12: 90-4(Mar. 1967). (In Italian).

The effects produced by total irradiation with single lethal and single non-lethal doses of Roentgen rays on the lipides present in the free cytoplasmatic fraction of albino rat liver were examined. The methyl esters were subjected to gas-chromatography and this showed quantitative alterations, especially in palmitic, palmitoleic, stearic, oleic, linoleic, and arachidonic fatty acids leading to an increase in saturated fatty acids with respect to unsaturated. (auth)

28378 BEHAVIOUR OF FREE CYTOPLASMATIC FATTY ACIDS OF LIVER IN PANIRRADIATED RATS. Pallavicini, E. Bobbio; Slaviero, G. E.; Zanetti, A. (Univ., Pavia, Italy). Minerva Radiol., Fisioterap. Radiobiol., 12: 94-6(Mar. 1967). (In Italian).

The variations provoked by x irradiation with lethal and sublethal doses on the hepatic lipides of albino rats were studied. The material examined consisted of the free cytoplasmatic fraction after isolation of the nuclear and mitochondrial fractions. The lipides obtained were analyzed by means of gas-chromatography in columns. A fair degree of variation was observed in the percentages of the single fatty acids studied, leading generally to an increase in the ratio saturated fatty acids/unsaturated acids, on the increase in the former and corresponding fall in the latter. (auth)

28379 DETECTION OF LOW-ENERGY β-RADIATION IN THE PRESENCE OF AN EMITTER OF γ-RADIATION IN BIOLOGIC MATERIAL. Chwalinski, Stanislaw; Mikulski, Andrzej (Zaklad Patofizjologii Instytutu Reumatologicznego, Warsaw). Acta Physiol. Pol., 18: 121-30(Jan.-Feb. 1967). (In Polish).

A method has been developed of measuring low-energy β radiation while determining the levels of total and extracellular water in the same individual. Tritium (^3H) was employed as emitter of low-energy β radiation in the form of tritium water (HTO) and bromine-82 as emitter of β and γ radiation in the form of $NH_4{}^{82}Br$ for determining the levels of total and extracellular water. The experiments were carried out with Wistar rats of both sexes and different body weights. The aforementioned markers were injected intraperitoneally. In the first phase, levels of extracellular water were determined by measuring the activity of ^{82}Br in body fluids by means of a scintillation counter with NaI (Tl) crystal eliminating the influence of β radiation of tritium. Next, taking advantage of the property of halogens of forming difficultly water-soluble sediments with silver Ag^+ ions, Br^- ions were removed from the solution by means of silver nitrate. Under the chosen conditions precipitation was complete, allowing exact measurement of activity of tritium contained in the body fluid and estimation of the level of total water. The results were in agreement with generally accepted values. The method also allows study of changes in the spaces occupied by the extra- and intracellular fluids under the influence of external stimuli. As an example, the influence of raised temperature on the level of body fluids was studied, demonstrating an increased level of extracellular water and diminished level of total water. (auth)

28380 RADIATION-PRODUCED AGGREGATION AND INACTIVATION IN EGG WHITE LYSOZYME. Stevens, C. O.; Sauberlich, H. E.; Bergstrom, Glenn R. (Fitzsimons General Hospital, Denver). J. Biol. Chem., 242: 1821-6(Apr. 25, 1967).

Chromatographically homogeneous egg white lysozyme has been subjected under reduced pressure to 0.67-MeV γ rays. At 37% destruction of enzymic activity, three inactive aggregates and one partially active fraction have been isolated by salt precipitation and chromatographic procedures. The aggregates, upon reduction with 2-mercaptoethanol and reaction with iodoacetic acid, give derivatives with molecular weights of 12,000 to 15,750 in comparison with one of 14,500 for reduced carboxymethylated lysozyme. One urea-insoluble aggregate becomes soluble upon reduction and, after air oxidation, in dilute solution gives active enzyme in 15% yield. Mixed disulfides of cystine and this or other inactive fractions also give significant (10 to 20%) yields of active enzyme upon incubation with cysteine. Disulfide analyses showed close to the expected number of disulfide bonds in two of the mixed dusulfide derivatives if one assumes no fragmentation but simply aggregation of lysozyme monomer molecules. Amino acid and disulfide content of the active component from reactivation of one mixed disulfide derivative agreed well with that found for the active component from reactivation of the mixed disulfide of native lysozyme. Thus a signif-

icant portion (15 to 20%) of radiation inactivation in solid lysozyme can be explained by the rupture of disulfide bonds followed by formation of "incorrect" intermolecular disulfide bonds. (auth)

28381 MOLECULAR PATHOLOGY OF IRRADIATION. Van Lancker, J. L. (Univ. of Wisconsin, Madison). Lab. Invest., 15: 192-5(Jan. 1966).

A survey was made to determine which compounds are the primary targets of x radiation. The assumption that x radiation affects only one or a few biochemical compounds is reasonable. The number of free radicals formed after the administration of a lethal dose of x radiation could only account for damage to a small proportion of the macromolecules present in the cell. Therefore, either the free radicals must attack some component at the exclusion of others, or some cellular component vital to cellular proliferation must be highly radiosensitive. Since irradiation drastically interferes with DNA synthesis, the effects of radiation on each of the reactions involved in DNA synthesis are examined. It is concluded that irradiation blocks DNA synthesis and the block does not result from changes in the activity of thymidylic kinase or DNA polymerase, but might result from interference with the biosynthesis of other proteins necessary for DNA synthesis in mammalian tissues. Irradiation interferes with the biosynthesis of some newly synthesized proteins in regenerating liver, possibly by blocking the biosynthesis of that fraction of mammalian nuclear RNA that plays the role of the bacterial messenger-RNA. The molecular target of radiation might be either DNA or the molecular mechanism that makes DNA available as primer for DNA or RNA synthesis. (BBB)

28382 CONTINUOUS MEASUREMENT OF RESPIRATORY $^{14}CO_2$ AND CO_2 PATTERNS IN MICE. Matsuoka, Osamu; Muramatsu, Emiko (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 15: 346-53(Nov. 1966). (In Japanese).

A 4π gas flow sandwich type G-M tube apparatus connected to anticoincidence circuit, log rate meter, and recorder was employed for a $^{14}CO_2$ flow detection system. A new technique was developed, which records the integral radioactivity of expired $^{14}CO_2$ on chart paper by the transient zero drift in the rate meter. A Beckman Medical Gas Analyzer LB-1, the principle of which is based on infrared absorption, was used for stable CO_2 flow detection. The air supply to test mice was carried out by compressed air set in the flow rate of 80 ml/min. About 3,000 cpm at the maximum rate of radioactivity in expired air following the injection of 4 μCi/mouse of ^{14}C-glucose was detected by the above apparatus under the background count of about 30 cpm. The dimensional effect of the animal chamber on respiratory $^{14}CO_2$ pattern was studied and an optimum chamber was designed. The several problems which will affect the respiratory $^{14}CO_2$ patterns were studied. These included fasting, carrier additions, route of administration, difference of labeling position, and possibility of multiple applications of the ^{14}C-glucose test. (NSA of Japan)

28383 EFFECT OF X IRRADIATION ON YOSHIDA ASCITES TUMOR CELLS IN VIVO. AN ELECTRON MICROSCOPE STUDY. Kato, Toshio (Tohoku Univ. Medical School, Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 209-25(June 25, 1962).. (In Japanese).

Changes of the submicroscopic structures of Yoshida ascites tumor cells after 250 to 500 R x irradiation in vivo were studied using an electron microscope. These doses were given to male rats four days after inoculation of the tumor cells. Ascitic fluid was removed just before irradiation and at 1, 3, 6, and 12 hr after the exposure to x rays. Cells for electron microscopy were stained with uranyl acetate solution. Among the changes seen after irradiation, the cell surface was rounded owing to the disappearance of microvilli. Chromatin condensation on the nuclear envelope was followed by vacuolation of the nuclear contents; that is, chromatolysis occurred. Thickening of the nuclear membrane was observed in these cells. Pycnotic nuclei were also found occasionally and the nucleolus tended to agglutinate. Ribonucleoprotein particles, diffusely distributed in the cytoplasm, were diminished markedly so that the cytoplasm became less electron dense. Various degrees of destruction, swelling, and vacuolation of mitochondria were observed frequently, and their restoration was also seen at intervals of as little as 3 hr following irradiation. Soon after irradiation, endoplasmic reticulum of the lamella type appeared around the nucleus. A close relation between regenerating mitochrondria and endoplasmic reticulum was evident in later periods. Among these changes, the most intensive ones, complete chromatolysis and cytolysis, which were considered to express the death of the cell, were found most frequently in animals 1 hr after the irradiation with 500 R. Restorative changes were found 3 hours or more after irradiation. (BBB)

28384 FREE RADICAL THEORY OF AGING: FREE RADICAL REACTIONS IN SERUM. Harman, Denham (Univ. of Nebraska, Omaha); Piette, Lawrence H. J. Gerontol., 21: 560-5(Oct. 1966).

In view of the similarity of ionizing radiation-produced arteriolocapillary fibrosis (apparently medicated primarily via the free radicals arising in the radiation-induced dissociation of water) with that of normal aging, it is postulated that endogenously formed plasma free radicals may be a major cause of the change occurring with time in the vascular system. Such small vessel fibrosis may contribute to aging, both normal and radiation-induced, by interfering with the proper nutrition of parenchymal cells, decreasing the rates of delivery of nutrients and oxygen, and removal of metabolites. Experiments were conducted to determine whether free radical reactions can be detected in serum with the aid of the sensitive technique of electron spin resonance (ESR) absorption spectroscopy and, if so, to try to identify the reactions giving rise to the observed free radical signal. Free radicals were detected in vitro in human serum at room temperature by ESR spectroscopy; the serum signal, observed only at $g = 2.004$, was enhanced slightly by oxygen. The enhancing effect of oxygen on the serum signal was markedly increased by uv irradiation; with continued irradiation the signal gradually returned toward that found in nitrogen. A signal increase was also seen if cumene hydroperoxide, tert-butylhydroperoxide, or the hydroperoxide of methyl linoleate were added prior to uv irradiation in either air or nitrogen (the peroxides undergo photodecomposition to RO· and HO· radicals). The serum signal was also increased by treatment with Ce^{4+} in a flow system. The increase in the signal seen upon uv irradiation of serum in the presence of oxygen probably was a result of photoxidation. The data are interpreted to indicate that the serum ESR signal is probably the resultant, at least in part, of the reaction of molecular oxygen with proteins, lipids, and smaller molecules such as ascorbic acid and epinephrine. (BBB)

28385 DOSE-RATE DEPENDENCE OF RADIATION-INDUCED METAPHASE DELAY. Oldfield, D. G. (Univ. of Chicago). Bull. Math. Biophys., 29: 41-56(Mar. 1967).

By visually following single cells, irradiated when in prophase, through the remaining stages of mitosis, it can be shown directly that the time spent by such cells in mitosis is on the average longer than that for unirradiated cells, and that this time increases as the dose increases. A model is formulated for this phenomenon which relates the time that an irradiated cell requires to reach metaphase to the radiation dose and dose rate. The principal mechanism producing metaphase delay is assumed to be the failure of chromosome coiling in prophase due to radiation-induced effects on chromosomal structural protein fibers. The equation relating radiation-induced metaphase delay to the dose-rate and duration of irradiation which was obtained was derived from a model specifying the effects of radiation on the normal chromosome coiling process. The basic assumptions of the model are that normal coiling proceeds by contractile protein acting on segments of a viscoelastic chromosomal fiber and that radiation causes cross-linking of adjacent chromosomal fibers which hinders the coiling process. (BBB)

28386 STUDIES ON RADIATION-INDUCED EFFLUX OF POTASSIUM FROM ERYTHROCYTES. Nakken, K. F.; Prydz, P. E. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scan. J. Clin. Lab. Invest., 17: Suppl. 86, 169(1965).

To maintain the large concentration gradients of cations across the erythrocyte membrane, a large fraction of the membrane sulfhydryl groups probably must be kept in their native state. The most active membrane sulfhydryl groups (7% of the total) may, however, be alkylated without concomitant interference with various membrane functions. The x-ray-induced potassium efflux is found to be unaffected by pretreatment of erythrocytes with iodoacetate ($IAA = 5 \times 10^{-4}$ M), whereas a strong radiosensitizing effect is observed when IAA is present during irradiation. Experiments supported the view that x rays (and oxidizing agents) may give rise to a short-lived sensitized state of the erythrocyte membrane, probably by breakage of hydrogen bonds. The rapid potassium efflux induced by x rays in erythrocyte suspensions containing low concentrations of IAA is probably due to the interaction of OH radicals with the cell membrane, thereby unmasking sensitive sites to the action of the alkylating agent. This conclusion is based on the finding that the sensitizing effect of IAA is abolished in the presence of a specific OH scavenger such as p-aminobenzoic acid. (BBB)

28387 HISTOCHEMICAL EVIDENCE OF SOME DEHYDROGENASES IN THE EMBRYONIC AND ADULT CARTILAGE IN NORMAL OR X-IRRADIATED MICE. Novel, Madeliene (Institut National des Sciences Appliques, Villeurbanne, France). Compt. Rend., Ser. D, 264: 1657-9(Mar. 20, 1967). (In French).

The presence of uradinediphosphoglucosedehydrogenase on 16 day old mouse embryonic tissues and of lactate and malate dehydrogenase in 15-day embryos was shown. A 500-R dose in whole

body irradiation does not seem to decrease in the hours following these enzymatic activities in the adult or the embryo at term. (tr-auth)

28388 SOME OBSERVATIONS ON THE PROBLEM OF THE INTERNAL DECONTAMINATION OF RADIOELEMENTS. Brenot, A.; Chiadot, P.; Rinaldi, R. (CEN, Grenoble, France). Ann. Biol. Clin. (Paris), 24: 1223-30(Oct.-Dec. 1966). (In French).

The effectiveness of chelating agents in increasing the elimination of ^{134}Cs, ^{59}Fe, and ^{203}Hg from the body was determined. Total excretion of ^{134}Cs over a period of 3 days reached ~95% in rats given ferric, calcium, or cobalt ferrocyanide and ~88% in those given bismuth ferrocyanide. It was found that the $LD_{50/30}$ for the Fe, Ca, and Bi salts was ~1 mg/g and ~4.1 mg/g for the Co salt. Autoradiography 24 hr after rats were given $^{134}CsCl$ showed that the salts prevented deposition of the radioisotope in muscle tissues. In rats given $^{59}Fe(III)$, treatment with Ca diethylenetriaminepentaacetate (DTPA) produced a total excretion of 11.5% of the administered amount in 4 days; Desferrioxamine B gave 16.3% excretion. In rats contaminated with ^{203}Hg, as $HgCl_2$, treatment with Ca ethylenediaminetetraacetate (EDTA) increased excretion to 13.4% and Ca DTPA increased it to 29.7%. The sulfhydryl agent British Anti-Lewisite (BAL) increased it to 38.8%, and DL-penicillamine increased it to 44.8%. With penicillamine the 11-day excretion level reached 93.5% of the injected amount of ^{203}Hg. (BBB)

28389 THE IRRADIATION OF STARCH. PART I. THE PROPERTIES OF POTATO STARCH AND ITS COMPONENTS AFTER IRRADIATION WITH HIGH-ENERGY ELECTRONS. Greenwood, C. T.; MacKenzie, C. (Univ. of Edinburgh). Staerke, 15: 444-8(Dec. 1963).

Properties of potato starches treated with high energy electron doses as high as 10^7 rads and the effects of the radiation on the properties of the amylose and amylopectin components in the granule were investigated Starch, contained in polyethylene bags in an atmosphere of nitrogen, was irradiated with high-energy electrons from a 2-MeV Van de Graaff generator at doses ranging from 5×10^4 to 10^7 rads. There was no obvious damage to the granular structure under microscopic observation, and all starches exhibited birefringent properties. Furthermore, the behavior on gelatinization and the gelatinization temperatures were not altered appreciably, except for the 10^7-rads sample. As the radiation dose was increased, there was a decrease in iodine binding-power of the starch. The changes induced by the high-energy electrons in samples receiving 0.05 to 0.2 Mrads were identical to those for the acid-degradation of potato starch granules. For samples treated with 0.5 Mrads the modification of the starch was so profound that the usual sigmoidal adsorption isotherm was not found, and, furthermore, the concentration of free iodine necessary to saturate the sample increased. The shape of the iodine-binding curves indicated a radical loss of iodine-binding material, and suggested that the amylose component of starch was degraded. Decomposition products of irradiated starches that were pyrolyzed in vacuo at 300°C were examined by gas chromatography and the chromatograms obtained were identical to those for nonirradiated starches. Therefore, small molecular weight fission products did not appreciably alter the pyrolysis pattern of the polymer. Results of viscosity and sedimentation measurements revealed that amylose and amylopectin components underwent gross molecular degradation during irradiation. This depolymerization was accompanied by structural modifications, as indicated by changes in susceptibility to degradation by β-amylase and Z-enzyme. (TSS)

28390 γ IRRADIATION OF STAPHYLOCOCCAL ENTEROTOXIN B. Read, R. B. Jr.; Bradshaw, J. G. (Robert A. Taft Sanitary Engineering Center, Cincinnati). Appl. Microbiol., 15: 603-5(May 1967).

The inactivation of enterotoxin B by γ irradiation was studied by use of single- and double-gel-diffusion assay techniques. Enterotoxin B (99 + % purity) was suspended either in 0.04 M Veronal buffer (pH 7.2) or in milk, dispensed and heatsealed in borosilicate glass vials, and irradiated essentially at 21 to 26 C with a cobalt-60 source. Parallel titrations of irradiated enterotoxin B in Veronal buffer were made by use of gel-diffusion and cat assay procedures to establish the relative sensitivity of these two assay procedures to irradiated enterotoxin. Results were identical. A dose of 5 Mrad was required to reduce an enterotoxin B concentration of 31 μg/ml in Veronal buffer to less than 0.7 μg/ml. When milk was used as a vehicle, a dose of 20 Mrad was needed to inactivate a 30 μg/ml concentration of enterotoxin B to less than 0.5 μg/ml. With Veronal buffer and milk as vehicles, the D values (dose required to inactivate 90%) for enterotoxin B inactivation were 2.7 and 9.7 Mrad, respectively. (auth)

28391 VARIATIONS OBSERVED IN THE PROCESS OF RESPIRATION OF VEGETABLE TISSUE UNDER GAMMA-IRRADIATION. Petrash, I. P.; Metlitskii, L. V. Dokl. Akad. Nauk SSSR, 170: 711-13(Sept. 21, 1966). (In Russian).

Experiments were carried out on tomatoes exposed to 300 krads of γ radiation at varying stages of ripeness. Results confirmed previous observations that the intensity of the respiration of the fruit was somewhat increased during the first few days after exposure. No decrease in the activity of oxidizing ferments, such as cytochrome oxidase, ascorbate oxidase, peroxidase and polyphenol oxidase was noted; to the contrary, the peroxidase was actually activated, especially in the green fruits. The radiation-induced changes in the respiratory chain were examined under observation of the behavior of the terminal oxidase and their specific inhibitors. The results indicated that irradiation affects strongly the terminal oxidases, especially the cytochromes. In view of the fact that the intensity of respiration itself is not affected, it appears probable that the irradiation causes a change in the path of the electrons through the cytochrome–cytochrome oxidase in the energetically less effective direction. This might result in a recovery from radiation injury. (TTT)

28392 EFFECT OF γ IRRADIATION UPON THE ALKALINE PHOSPHATASE IN RAW MILK. Umemoto, Yaichiro, Sato, Yasushi (Univ. of Nagoya, Japan). Nippon Nogeikagaku Kaishi, 35: 591-5(1961).

Alkaline phosphatase in raw milk is a minor enzyme component and one criterion of pasteurization is the degree of the inactivation of this enzyme. In a study of some fundamental problems in use of ionizing radiations in milk processing, after raw milk was irradiated with γ rays or heated, or treated with the combination of radiation with heating, the inactivation rates of the enzyme were measured. Correlation of the inactivation of the enzyme with the destruction of bacteria in milk was also examined. A plot of the dose against the logarithm of the residual enzyme activity in milk was linear and enzyme inactivation in whole and skim milks was different from that in cream. It was found that this was due to the differences of the composition, especially water and protein, in the three samples. Inactivation seemed to be increased by the water contents and to be decreased by the milk proteins. The process of the inactivation of the enzyme by heat treatment was distinctly different from that by irradiation. With heating at 60°C after irradiation at 1.5 MR the effect of irradiation upon the enzyme in raw milk was most striking, but heating at 60°C after irradiation at 1 MR was also effective for enzyme inactivation. No relation was found to exist between the destruction of bacteria and inactivation rates of the enzyme. The bacteria in raw milk were almost eradicated at a dose of 1 MR and completely so at 1.5 MR. With heating at 55°C after irradiation, raw milk was incompletely sterilized at 0.5 MR and completely so at 1.0 MR. (BBB)

28393 STUDIES ON THE DETERMINATION OF BODY COMPOSITION OF LIVING PIGS BY ^{40}K GAMMA RADIOACTIVITY MEASUREMENTS. II. THE POTASSIUM CONTENT OF THE MUSCULATURE OF PIGS WEIGHING 110 Kg. Pfau, A.; Kallistratos, G. (Max-Planck-Institut fuer Tierzucht und Tierernaehrung, Mariensee/Trenthorst, Ger.). Z. Tierzuecht. Zuechtungsbiol., 79: 249-60(1963). (In German).

Studies were continued on the development of a method using measurements of ^{40}K whole-body activity to determine lean muscle mass of pigs. A female pig of the German improved landrace breed was used for the analysis of K content of all the muscles and various other body components. The pig had a live weight of about 110 Kg. The K content as related to fat-free dry matter, fat-free dry matter minus ash, nitrogen, and protein in muscles was found to be constant from muscle to muscle. There was no evidence that the mean values calculated from all the muscles of one pig were different from those obtained from single muscle K analysis in 60 pigs as reported previously. Therefore, the data from both studies could be used to calculate mean K ratios which should be independent of breed, sex, and muscle type of pigs at a weight of 110 Kg, within tolerable biological variations. The mean K ratios of the nonmuscular body components were considerably lower. Only the larger organs showed mean values comparable to those of the muscles. (BBB)

28394 FISSION PRODUCTS: RETENTION AND ELIMINATION OF THE PARENT-DAUGHTER RADIONUCLIDE PAIR ^{103}Ru–^{103m}Rh BY RATS. Sastry, V. Rama (Vanderbilt Univ., Nashville). Toxicol. Appl. Pharmacol., 9: 419-30(Nov. 1966)

Retention patterns of ^{103}Ru–^{103m}Rh in the rat were studied by whole-body counting techniques. The biological half-time for ^{103}Ru–^{103m}Rh in the rat was found to be 4.3 days. The animals lost 50% of the original radioactivity in about 3.6 days. The concentrations of ^{103}Ru–^{103m}Rh in tissues at the end of the fourth day (i.e., at the end of about one biological half-time) are reported. The tissues could be arranged in the following order according to the concentrations of ^{103}Ru–^{103m}Rh found in them: kidney > liver > bone > muscle. The effective physical half-life (37 days) of ^{103}Ru–^{103m}Rh accumulated in kidney, bone, and muscle was equal to that

of $^{103}Ru-^{103m}Rh$ in the administered dose. The effective physical half-life of the radionuclides in the liver was 38 days. The major route for the elimination of $^{103}Ru-^{103m}Rh$ in the rat was urinary excretion. About 36 to 28% of the dose was eliminated in the urine during the first 24 hr. The ratio of $^{106}Ru:^{103}Ru$ in the urine collected during 1 to 4 days was higher than that in the administered dose, indicating that the kidney may differentiate between ^{103}Ru and ^{106}Ru. (BBB)

28395 FISSION PRODUCTS: RETENTION AND ELIMINATION OF THE PARENT-DAUGHTER RADIONUCLIDE PAIR $^{140}Ba-^{140}La$ BY RATS. Sastry, V. Rama; Owens, Lillian K. (Vanderbilt Univ., Nashville). Contract AT(40-1)-3066. Toxicol. Appl. Pharmacol., 9: 431-44(Nov. 1966).

Retention patterns of $^{140}Ba-^{140}La$ in the rat were studied by whole-body counting techniques. The animals lost 50% of the original radioactivity in about 6.5 days. In about 3 to 4 days, nearly 24 to 25% of the administered $^{140}Ba-^{140}La$ was excreted, and 75 to 76% of the dose was retained. The activities of $^{140}Ba-^{140}La$ in bone, muscle, and blood as a function of time are reported. The peak concentration of $^{140}Ba-^{140}La$ was found in bone at the end of the fourth day. The parent (^{140}Ba) and the daughter (^{140}La) isotopes were nearly in transient equilibrium in the sample of $^{140}Ba-^{140}La$ found in the bone at the end of the fourth day. The effective physical half-lives suggested that ^{140}Ba shows more preference than ^{140}La to accumulate in bone. The major route for the elimination of $^{140}Ba-^{140}La$ seemed to be the feces. About 8% of the dose of $^{140}Ba-^{140}La$ was excreted in urine, while about 16% of the dose of $^{140}Ba-^{140}La$ was eliminated by routes other than urine in 4 days after intraperitoneal administration of $^{140}Ba-^{140}La$. Kidney differentiated between the parent and the daughter isotopes because the ratio $^{140}Ba:^{140}La$ was higher in the urine than in the dose of $^{140}Ba-^{140}La$. Renal tissue showed a preference to retain ^{140}La. (BBB)

28396 STUDIES ON THE DETERMINATION OF BODY COMPOSITION OF LIVING PIGS BY ^{40}K GAMMA RADIOACTIVITY MEASUREMENTS. I. THE POTASSIUM CONTENT OF M. LONGISSIMUS DORSI AND M. SEMIMEMBRANACEUS IN PIGS WEIGHING 110 Kg OF DIFFERENT SEX AND BREEDS. Pfau, A.; Kallistratos, G.; Ossowski, B.; Hoeck, H.; Zivkovic, Z. (Max-Planck-Institut fuer Tierzucht und Tierernaehrung, Mariensee/Trenthorst, Ger.). Z. Tierzuecht. Zuechtungsbiol., 78: 179-95(1963). (In German).

Preliminary studies are reported on the development of a whole-body γ radiation detection method to determine the ^{40}K content, and thereby the lean muscle mass of pigs. Sixty castrated male and intact female pigs of three breeds, German improved landrace, Dutch improved landrace, and Belgian Pietrain were used at a live weight of 110 Kg. The pigs were maintained under the same feeding and housing conditions. Samples of the longissimus dorsi and semimembranaceus muscles were assayed under standardized conditions to determine the K content in relation to other meat components. The mean K content of the intact muscle samples was found to be independent of sex but showed statistical significant differences between breeds and muscles. However, no differences were found between breeds, muscles, or sexes when the K content was related to the fat-free dry matter or to fat-free dry matter minus ash. (BBB)

28397 ARGINASE ACTIVITY IN EPIDERMIS FOLLOWING ULTRAVIOLET EXPOSURE. Ishihara, Nobumitsu (Kurume Univ. School of Medicine, Japan). Kurume Med. J., 12: 77-85 (1965).

An attempt to observe the initial effect of uv radiation on arginase activity in the epidermis of rats was made. The average arginase level in normal rat epidermis was 32.3, expressed as $X\ 10^9$ mg urea N/hr/100 g dried weight. After a single exposure to uv radiation (7.5×10^5 erg/cm^2), the arginase activity decreased significantly to about 10% below the normal level; it returned to normal within 2 weeks after exposure. The protein-bound SH was determined on the basis of the possibility that protein-bound SH might reflect structural changes of epidermal protein and enzyme. A single exposure to uv radiation caused fluctuating changes in the protein-bound SH. These results suggested that denaturation of epidermal protein or enzyme occurred relatively early after exposure; after daily repeated exposure to uv radiation, arginase activity decreased. When the total dose reached 7.1×10^7 erg/cm^2 at the end of 4 months, the arginase activity was 19.4×10^2 mg/hr/100 g dry weight. (BBB)

28398 THE USE OF ^{95}Nb-LABELED ALBUMIN IN THE STUDY OF GASTROINTESTINAL PROTEIN LOSS. Jeejeebhoy, K. N.; Singh, B.; Mani, R. S.; Sanjana, S. M. (Atomic Energy Establishment, Bombay). pp 61-7 of Physiology and Pathophysiology of Plasma Protein Metabolism, Proc. 3rd Symp., Grindelwald, Switzerland, Sept. 10 to 12, 1964. New York, Grune and Stratton, 1965.

A new radioisotope label for serum albumin for use in scanning studies of albumin turnover and blood loss is reported. A method for preparing ^{95}Nb-labeled albumin and a procedure for separating free ^{95}Nb from protein is described. The labeling efficiency of the outlined method was found to vary from 30 to 60%; the product remained stable 3 to 4 weeks. For the study of albumin turnover and gastrointestinal albumin loss, 20 μCi of ^{95}Nb-albumin was intravenously injected into control subjects and patients. Blood was withdrawn into a heparinized syringe 10 min after the injection and daily for 10 to 12 days. Simultaneously, 24-hr urine and fecal collections were made. From the results it was apparent that ^{95}Nb was a nonabsorbable isotope that could be firmly bound to albumin. (TSS)

28399 THE γ RADIOLYSIS OF CYSTEINE IN DEAERATED 1 N $HClO_4$ SOLUTIONS. Wilkening, Verna Gaye; Lal, Manohar; Arends, Meta; Armstrong, D. A. (Univ. of Calgary, Alberta). Can. J. Chem., 45: 1209-23(June 1, 1967).

The G values for the formation of H_2, H_2S, alanine (CyH), and cystine ($(CyS)_2$) in the ^{60}Co γ-radiolysis of 10^{-3} and 10^{-2} M solutions of cysteine (CySH) in 1 N perchloric acid at 23°C were determined. They were quantitatively consistent with the following reaction mechanism: $H_2O \rightsquigarrow G_{H_2}{}^{M}(H_2) + G_{H_2O_2}{}^{M}(H_2O_2) + G_H(H) + G_{OH}(OH)$; $H + CySH \rightarrow CyS + H_2$; $H + CySH \rightarrow CY + H_2S$; $OH + CySH \rightarrow CyS + H_2O$; $Cy + CySH \rightarrow CyH + CyS$; $2CyS \rightarrow (CyS)_2$. The yields of H_2 and H_2S were also measured at 1 ± 1°C. If H atoms were assumed to be the only reducing species in 1 N perchloric acid, k_1/k_2 was found to be 3.5 at 23°C and 8 at 1°C. (auth)

28400 PYRIMIDINE DIMER FORMATION IN ULTRAVIOLET IRRADIATED TMV-RNA. Merriam, Virginia; Gordon, Milton P. (Univ. of Washington, Seattle). Photochem. Photobiol., 6: 309-19(May 1967).

The formation of pyrimidine dimers in aqueous solutions of uv irradiated tobacco mosaic virus-RNA (TMV-RNA) was demonstrated in the 254 nm to 302 nm region. No dimer was present in either nonirradiated E. coli ribosomal RNA or TMV-RNA. Dimer formation was also examined in TMV-RNA irradiated in the presence of high salt concentration, low temperature, 90% methanol, and 5×10^{-6} M proflavin. No correlation of pyrimidine dimers with any biologically defined lesions was found: it is suggested that dimers were not involved in the uv inactivation of TMV-RNA; uv inactivation of TMV-RNA was attributed to pyrimidine hydrate formation. (TSS)

28401 STUDIES ON RESIDUE ANALYSIS OF PESTICIDES IN PLANT MATERIALS. II. NEUTRON ACTIVATION ANALYSIS OF MERCURY IN RICE GRAINS. Tomizawa, Chojiro (National Inst. of Agricultural Sciences, Tokyo); Koshimizu, Yukio. Shokuhin Eiseigaku Zasshi, 7: 33-8(Feb. 1966). (In Japanese).

Neutron activation analysis was used to determine the mercury content of rice grains. Sensitivity of the procedure used allowed accurate determinations of quantities more than 1 μg. Samples of raw and polished grain were obtained from fields to which various amounts of phenylmercuric acetate disinfectant had been applied. Mercury content of the rice grain increased linearly with the amount of disinfectant applied in the field. Higher mercury levels in raw rice indicated the possibility that the mercury was concentrated in the bran portion of the grain. (TSS)

28402 ^{28}Mg KINETICS IN MAN. Avioli, Louis V. (Washington Univ. School of Medicine, St. Louis); Berman, Mones. J. Appl. Physiol., 21: 1688-94(Nov. 1966).

After intravenous injection of ^{28}Mg in 15 normal adults on metabolic balance regimens, a multicompartmental-type analysis was used to describe the isotopic and metabolic data. Of the injected radioactivity, 7.27 to 17.3% (mean 10.6) was recovered in the urine within 48 hr and 15.0 to 23.4% (mean 16.9) within 6 days. Cumulative fecal radioactivity averaged 1.78% at 48 hr and 2.61% at 6 days. The compartmental sizes and transfer constants were obtained with the NIH-OMR-SAAM program and an IBM 7094 computer. Only 15% of the estimated whole-body Mg could be accounted for by rapid exchange processes, with total-body exchangeable Mg averaging 3.54 meq/Kg body weight. Two rapidly exchanging compartments when combined approximated extracellular fluid in distribution and a third, containing over 80% of the total exchangeable pool, reflected intracellular Mg. The data also suggested the presence of another Mg compartment accounting for most of whole-body Mg which exchanges very slowly, with an estimated biological half-life of 1000 hr. (BBB)

28403 INFLUENCE OF FRACTIONATED X-RAY DOSES ON PHENYLHYDRAZINE TREATED RABBITS. II. EFFECTS ON THE METABOLISM AND ON THE AGING PROCESSES OF ERYTHROCYTES. Fantoni, A.; Segni, P.; Leoncini, G. (Univ., Genoa). J. Nucl. Biol. Med., 10: 110-14(July-Sept. 1966).

The oxidative and nonoxidative utilization of glucose, the effect of methylene blue on metabolism, the hexokinase and glucose-6-

phosphate dehydrogenase activities were studied in erythrocytes from phenylhydrazine treated rabbits exposed to x radiation. These metabolic and enzymatic activities were studied during the whole aging process of erythrocytes produced under the effect of irradiation. No significant changes were detected in red cells from irradiated animals in comparison to controls. It was concluded that the red cells that can differentiate and mature in spite of the irradiation insult did not show any apparent metabolic alteration. (auth)

28404 ^{131}I UPTAKE AND PROTEIN-BOUND IODINE IN NORMAL ADULT BEAGLES. Quinlan, William Jr.; Michaelson, Sol M. (Univ. of Rochester, N. Y.). Amer. J. Vet. Res., 28: 179-82(Jan. 1967).

Normal male and female Beagles, 2 to 14 yr old, were given intravenous inoculations of 15 to 60 μCi/ml of ^{131}I, and some dogs were given ^{131}I after the intravenous inoculation of 15 units of thyrotropin (TSH). A phantom of the thyroid gland was constructed of two concentric cylinders, an inner one containing a vial filled with ^{131}I solution and an outer one filled with water. To approximate the thyroid glands in the phantom, 15 dogs were thyroidectomized, and the thyroid glands weighed and measured. This provided a method for determining the exact dimensions of plastic vials to simulate the thyroid glands. The plastic vials were cut to the dimensions of the thyroid gland before being filled with the same dose of ^{131}I that was to be injected into the dog. There was a gradual build-up of ^{131}I in the thyroid gland, this reaching a peak 3 to 5 days after the injection. After the 5th day, there was a gradual decrease. Although there was a decrease in uptake values, the dogs retained 19% of the injected activity at the end of the 9-day study. There was no significant difference with advancing age. Regression analysis of PBI level did not reveal any correlation with age. The percentage increase in PBI above the normal value ranged between 18% for 9 units of TSH and a maximal increase of 63% for 20 units of TSH. A high correlation coefficient (0.986) was found between the TSH and PBI values. (BBB)

28405 PREPARATION OF RADIOIODINATED ALBUMIN FOR METABOLIC STUDIES. Rosa, U. (Nuclear Research Center, Saluggia, Italy). J. Nucl. Biol. Med., 10: 85-8(July-Sept. 1966).

A discussion on the damaging action of the steps in the preparation of radioiodine-labeled albumin suitable for use as a metabolic tracer is presented. A special labeling procedure, iodination at pH 7 by constant current electrolysis that permits controlled and reproducible conditions, is assessed. It was suggested that the following precautions be adopted: the selection of albumin batches should be based on short-term metabolic experiments and constant but high value catabolism rates; that the degree of iodination be kept between 0.5 and 1 iodine atom per molecule; that excess iodine be removed by dialysis or by elution on a Sephadex column (Anion exchange resins favored the formation of products that were rapidly degraded during the first few days of the metabolic experiments.); and that the specific activity should not exceed 40 to 60 μCi/mg and whenever possible ^{125}I rather than ^{131}I be used. (B.H.S.)

28406 IMPROVED TECHNIQUE FOR MEASURING CORONARY BLOOD FLOW BY THE ^{86}Rb SINGLE INJECTION METHOD. Chowjnik, A.; Torreggiani, G.; Donato, L. (Univ. of Pisa, Italy). J. Nucl. Biol. Med., 10: 89-94(July-Sept. 1966).

An improved technique for the simultaneous measurement in man of cardiac output (CO) and coronary blood flow (CBF), using the ^{86}Rb single injection method is presented. The method makes use of two gamma spectrometers, and presents as chief improvement the simultaneous injection and separate recording of the precordial curves due to the two tracers which are required for the measurement (^{86}Rb and ^{131}I-labeled human serum albumin). Cardiac output and CBF values were obtained in a group of 11 subjects, and repeated measurements were performed in 7 of them. The results indicated that CBF represented 4.96% of CO in normal males, and that the reproducibility of the method was satisfactory (+5.4% difference of second estimate from the first one in the average). The present method, in comparison to the previous one in which the two tracers were injected 5 to 10 min one after the other, presented the advantage that the data of the two isotopes reflected the same hermodynamic situation. This improvement was considered to be of particular importance for the study of changing states. (auth)

28407 METABOLISM OF FALLOUT ^{137}Cs IN BOVINE. Johnson, James Edward. Fort Collins, Colo., Colorado State Univ., 1966. 137p.

Thesis.

The parameters that govern the transfer of ^{137}Cs from fallout contaminated feed to milk and meat of cattle were investigated. The experimental work involved a large feeding trial designed to study at equilibrium the transfer of ^{137}Cs to milk from high hay or high grain diets. The per cent of daily intake secreted per liter was found to be 0.24 on the hay diet and 0.58 on the grain diet. The transfer of K was included for comparison with milk, urine, and fecal output of ^{137}Cs. All sample activities were determined by gamma-ray spectrometry. Tracer doses of orally administered ^{134}Cs were given at levels comparable to fallout ^{137}Cs to cows on high hay or grain diets. Both Cs isotopes could be determined in excreta simultaneously. The transfer of fallout ^{137}Cs to meat was found to be lower than determined from orally dosed ^{134}Cs at equilibrium. The reason for the unavailability of ^{137}Cs in fallout contaminated forages was found to be due to cation fixation by micaceous clay minerals on the plant surfaces. (TSS)

28408 THE EFFECT OF GAMMA IRRADIATION ON ENZYMES AND POLYPEPTIDES. Hayden, George Allen. Washington, D. C., Howard Univ., 1966. 91p.

Thesis.

An attempt was made to answer the question which type of molecular covalent lesion, concomitant with loss in enzymatic activity, causes the configurational changes the enzyme molecules undergo upon irradiation. When ATP-creatine phosphotransferase in solution was exposed to ^{60}Co γ-irradiation there was amino acid destruction and interconversion. Histidine was most radiosensitive when the intact protein was irradiated while methionine was most labile in the corresponding amino acid hydrolyzate in solution. Since rank in terms of radiation lability varies with individual proteins, stereochemical orientation was suspected as a determinant. Reconstitution of some amino acids by interconversion during radiation exposure enhance apparent stability of glutamic and aspartic acids, for instance, and their G values (number of molecules changed for each 100 electron-volts of energy absorbed) with reference to the protein will thus have a destructive and constructive component. Sulfhydryl groups disappeared at a faster rate than other amino acid side chains, and decline in enzymatic activity was even more rapid than destruction of -SH groups. Since ionizing radiation, when acting upon protein molecules, disrupts hydrogen bonds, destroy sulfhydryl groups, and effect other reactive groups on the side chain of the molecule, it was necessary to determine which of the three is predominant at a lower dose. In order to evaluate the effect of radiation on hydrogen bonding in proteins, an infrared spectral analysis at 1550 cm^{-1} of the time dependent decrease in the hard to exchange amide hydrogen (HEAH) with deuterium was employed. When irradiated in the solid state, ribonuclease appeared resistant to chemical covalent changes, however, enzymic activity declined at a rate similar to the decrease in HEAH. When the ribonuclease was irradiated in solution, the rate of destruction of the amino acids and that of the lowering of percent HEAH were of similar magnitude. Loss in enzymic activity by ribonuclease upon gamma-irradiation as solid occurred simultaneously with alteration in molecular structure. While there was definite indication for structural unfolding (increase in viscosity and increase in negative optical rotation) concomitant with the loss in enzymic activity, it appeared that these modifications were not extensive. For instance, the α(370 mμ) was -313 when enzymic activity was left after irradiation, but was -365 when ribonuclease was treated in 8 M urea with thioglycolate for reductive cleavage of disulfide bonds. Also, elevated extinction coefficients in ultraviolet spectral ranges (190 mμ and 280 mμ), when solid ribonuclease was irradiated, indicated structural unfolding. However, unmasking of such groups as tyrosyl (in opened molecules) may also have contributed to this effect. Since reduction and reoxidation of the irradiated ribonuclease did not effectively restore the enzymic activity, interchange in disulfide bonds alone could not explain the inactivation of the enzyme. Chemical studies on the disulfide interchange in the ribonuclease molecule upon irradiation confirmed this conclusion. The number average molecular weight was not changed by irradiation in the solid state which also established no intermolecular -S-S-interchange. ATP-creatine phosphotransferase irradiated in the solid state exhibited the same changes as ribonuclease: increasing viscosity; increasing ultraviolet extinction coefficients; and no increase in number average molecular weight. Polyamino acids and peptides were used as model systems for the enzyme and irradiated in solution and solid states. Transformation of amino acids upon gamma-irradiation of these peptides in solution was striking. However, irradiation of these peptides in the solid state at comparable doses showed no amino acid transformation. Polyamino acids irradiated in an evacuated solid state exhibited lower intrinsic viscosities and lower number average molecular weights as the result of molecular degradation. Proteins such as ribonuclease and ATP-creatine phosphotransferase, upon irradiation, exhibited increasing viscosity and no change in number average molecular weight probably because unfolding of the molecules and intramolecular croslinking masked the degradative action. (auth)

28409 INHIBITION DUE TO RADIATION. Goutier, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.); Bacq, Z. M. pp 631-50 of Metabolic Inhibitors, Vol. 2. Hochster, R. M.; Quastel, J. H. (eds.). New York, Academic Press, 1963.

This review, with 93 references, examines in vitro and in vivo

radiation effects, mainly on enzymes by direct and indirect action, role of protective agents, differences in RBE, and inhibition of various systems (DNA synthesis, auxin synthesis, oxidative and glycolytic processes, phosphorylation). Although an inhibitory action of radiation on enzymes is most frequently observed, activation is not a rare event in vivo and in some cases leads to reinforcement of the deleterious effect of the inhibition of other enzyme systems on the cell's life. The earliest detected biochemical lesion is the disturbance of nucleic acid metabolism and, especially, inhibition of DNA synthesis, where polymerization rate and formation of nucleoside triphosphates are both decreased. This, however, does not account for the antimitotic action of radiation, since it is often possible to inhibit mitoses without inhibiting the DNA synthesis to the same extent (a phenomenon which leads to the formation of giant cells). In some cases mitosis occurs without DNA synthesis, as in Tetrahymena. In plant tissues, irradiation may lead to increased cell growth or elongation without mitotic activity. Despite the broad insight gained on enzyme attack by radiation, no completely satisfactory explanation of the first observed effect of radiation, the mitotic block, can be offered. The mixture of inhibitions and activations of enzymes in irradiated tissues, which are described in this review, reflects the complexity of the reaction of such a highly organized body as a living cell when energy is deposited by ionizing radiation. Ionizing radiations, like other physical agents, do not inactivate a particular enzyme or series of enzymes in the tissues. After a short period of general metabolic stimulation, irradiation causes many aberrations in biochemical organization which lead to mitotic arrest, growth inhibition generally, and, at large enough doses, cell death. (BBB)

28410 RADIOISOTOPE IN DER GASTROENTEROLOGIE. Dritte Jahrestagung der Gesellschaft fuer Nuclearmedizin in Lausanne, 21–23 Oktober 1965. (Radioisotopes in Gastroenterology. Third Annual Meeting of the Society for Nuclear Medicine in Lausanne, October 21–23, 1965). Hoffmann, G.; Delaloye, B. (eds.). Stuttgart, F. K. Schattauer-Verlag, 1967. 352p. (CONF-651087).

Forty-nine papers were presented on various aspects of the physiology of the gastrointestinal tract. Carbon-14 was used in studies on the effects of radiation on intestinal absorption of sugars, amino acid absorption, resorption rate of lipids, resorption of ^{14}C-labeled 16-methylenprednisolone, and plasma protein turnover studies. Oxygen-18 was used in studies on effects of x radiation on intestinal absorption of sugars. Sulfur-35 was used in studies on amino acid absorption and plasma protein turnover. Chromium-51 was used in studies on gastrointestinal protein loss, iron resorption in various blood diseases, lactose malabsorption and lactose-induced enteric loss of protein. Iodine-131 was used as a label for triolein in clinical studies on liver cirrhosis, jaundice, diabetes mellitus and pancreatitis. Iodine-131-labeled polyvinylpyrrolidone was used in the diagnosis of exudative enteropathy and in studies on gastrointestinal protein loss in the nephrotic syndrome and in portal hypertonicity. Iodine-131 was also used in the following studies: detection of enteric protein loss, detection of hepatic metastases, skin permeability, extrathyroidal iodine kinetics, and regulatory mechanisms of thyroid function. Iodine-125 was used in studies on lactose-induced enteric loss of protein and in encephalography studies. Niobium-95 was used in studies on enteric protein loss. Iron-59 was used in studies on intestinal absorption of iron and excretion of iron in bile and the small intestine. Cesium-137, ^{22}Na, and ^{86}Rb were used in studies on resorption of alkaline ions through the small intestine of rats. Resorption and retention of ^{32}P were studied in whole-body counting. Potassium-40 was used in the determination of total potassium. Nitrogen-15 was used in studies on plasma protein turnover. Tritium was used in studies on plasma protein turnover and estrogen metabolism. Copper-64 and ^{67}Cu were used for the detection of enteric protein loss. (H.L.W.)

Ecology

28411 (IAEA–2607-13) ECOLOGY OF "ACANTHARIA" IN RELATION OF Sr CIRCULATION IN THE SEA (RADIONUCLIDES IN MARINE PLANKTON AND IN COASTAL SEDIMENTS). Final Report. Schreiber, B. (Parma Univ. (Italy). Istituto di Zoologia e Anatomia Comparata). Feb. 1967. Contracts AT-(30-1)-2607; US/62. 130p. Dep. CFSTI.

Acantharia are sea planktonic protozoa whose skeleton contains Sr sulfate. Results are reported from a study on the use of Acantharia as an indicator of the content and circulation of radioisotopes of Sr from fallout in ocean waters. Data are included from determinations of the ^{90}Sr content in samples of sea water collected at various locations; determinations of the ^{90}Sr content in plankton and in other benthonical sea organisms; zoological and ecological studies on Acantharia; studies on the distribution of Acantharia in plankton from various locations, with emphasis on Atlantic Ocean and Italian seas; and the content of total β activity and ^{90}Sr, ^{144}Ce, and ^{155}Eu in samples of marine sediments collected at various depth in Italian coastal waters. The effects of the presence of Acantharia in plankton on the concentration of ^{90}Sr was determined by taking advantage of the ecological situation of the Italian seas where the plankton of the Tyrrhenia Sea contains 10 to 60% Acantharia while they are absent in plankton in the Northern Adriatic Sea. Results showed that Acantharia are the main accumulating organism for ^{90}Sr in sea water and that they may be used as an indicator for ^{90}Sr distribution in ocean waters. Radiochemical analysis of sediment samples showed that fallout radioisotopes are only absorbed in the first 5 to 6 cm layer of sediment, with a sharp decrease from surface layers downward. (C.H.)

28412 (RLO–1725-82) NET ZOOPLANKTON DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, 1961, 1962. Technical Report No. 160. Peterson, Willis K.; Anderson, George C. (Washington Univ., Seattle. Dept. of Oceanography). Nov. 1966. Contracts AT(45-1)-1385; AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 231p. Dep. CFSTI.

Tabulations of net zooplankton data from 434 quantitative samples collected during 1961 and 1962 on the Research Vessel Brown Bear off the Washington and Oregon coasts are reported. The samples were collected in key areas in and around the Columbia River effluent to provide a description of seasonal variations of distribution and abundance of plankton associated with changes in the discharge of river water. Identification and enumeration of copepods was stressed. (auth)

28413 THE ^{90}Sr AND ^{137}Cs CONTENT OF CARP FROM NORTH GERMAN INLAND WATERS. Feldt, W.; Lange, J. (Institut fuer Fischverbereitung, Hamburg). Z. Lebensm.-Untersuch.-Forsch., 117: 103-13(1962). (In German).

The activities in samples of carp from standing waters such as Ploener Lake and the Great Inland Lake were significantly greater than in samples of carp from flowing waters such as the Elbe at Gorleben and Fliegenberg. This may have been caused by continuous increases in activity from fallout in standing waters, while in flowing waters there may be an equilibrium established between fallout input and outflow of water. As expected, the greatest ^{90}Sr content was observed in organs that contained the most Ca. The same was true for ^{137}Cs in organs rich in K. The ratio for ^{90}Sr in samples from flowing and standing waters was 1:2, while the corresponding ratio for ^{137}Cs was 1:10. The differences between these ratios was unexpected, and a suitable explanation could not be found because of the complexity of the environmental factors in these waters. In addition, the Sr and Cs activity values observed in organs of fish caught at the sample collection sites varied considerably, and suggested that extremely complex metabolic factors affected the passage of the radioelements through the organs of the carp. Concentrations of ^{90}Sr found ranged from 3 to 13 pCi/g Ca, and concentrations of ^{137}Cs ranged from 1 to 46 pCi/g K. (BBB)

28414 OBSERVATIONS ON THE UTILIZATION OF A NEUTRON PROBE FOR THE STUDY OF WATER ECONOMY OF PLANTS. Barrada, Y.; Decroux, J. (International Atomic Energy Agency, Vienna). Awamia, No. 14, 115-47(Jan. 1965). (In French).

An evaluation was made of the use of a neutron probe to investigate the water economy in corn plants in irrigated fields. The device was used particularly to measure available soil water and evapotranspiration, and, on the basis of the data obtained, to estimate field capacity and the wilting point. A 5-mCi radium-beryllium neutron source was used. In general, the results were satisfactory, the device and technic rapidly permitting an evaluation of water conditions in the soil. The readings obtained were proportional to the available water in the soil. Thus the neutron probe was valuable in establishing optimal soil-water conditions by irrigation and determining the optimal plant population density. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 28682 and 28695.

28415 (TID–23824) [EFFECTS OF POLYPLOIDY AND HYBRIDITY ON SENSITIVITY TO IONIZING RADIATION]. Three-Year Report, 1965–1967. Boyle, W. S. (Utah State University, Logan). Contract AT(11-1)-1404. 26p. Dep. CFSTI.

GRASSES — radioinduced lethality in Agropyron, dose required for; sterility of hybrids of Agropyron, effects of failure of synapsis on; radiation effects of ploidy of hybrid of Agropyron, effects of combined treatment with colchicine on γ and x; radiosensitivity of, comparison of species difference in

CHROMOSOMES — volume of interphase, in Agropyron (H.G.D.)

28416 GENETIC ANALYSIS OF AROMATIC MUTANTS OF SALMONELLA TYPHIMURIUM. Nishioka, Y.; Demerec, M.; Eisenstark, A. (Brookhaven National Lab., Upton, N. Y. Kansas State Univ., Manhattan). Genetics, 56: 341-51(June 1967).

Eighty-nine aro(multiple requiring), 20 tyr(tyrosine requiring, and 14 phe(phenylalanine requiring) mutants of Salmonella typhimurium were isolated from LT-2 and LT-7 strains as spontaneous mutants or after the strains were treated with 2-amino purine, 5-bromodeoxyuridine, diethylsulfate, ultraviolet radiation or x radiation. Complete and absortive transduction tests showed the presence of at least seven loci; five (aroA, B, C, D, E) having multiple requirements, one (pheA) requiring phenylalanine, and one (tyrA) requiring tyrosine. Joint transductions showed that the five aro loci were not linked, but tyrA and pheA loci were linked The aroD and tyrA loci exhibited interallelic complementation. The nutritional behavior of the aro mutants was complex. Requirements varied among alleles of each locus, from quintuple (tyrosine + phenylalanine + tryptophan + p-aminobenzoic acid + p-hydroxybenzoic acid) to quadruple (tyrosine + phenylalanine + tryptophan + p- aminobenzoic acid) to triple (tryosine + phenylalanine + tryptophan) to double (tyrosine + phenylalanine). Within the aroA locus, mutational sites of each phenotype (quadruple, triple or double requiring) tended to cluster. Quarduple requiring strains mutated into triple or double requiring strains by secondary mutations. (auth)

28417 X-RAY INDUCTION OF 2;3 TRANSLOCATIONS IN MATURE AND IMMATURE OOCYTES OF DROSOPHILA MELANOGASTER. Traut, H. (Univ., Muenster, Ger.). Genetics, 56: 265-72(June 1967).

Resistance to the induction of autosomal translocations induced by x rays in oocytes of Drosophila melanogaster was characteristic only of stage-7 oocytes (and the earlier stages), while in stage 14, translocations were readily induced. With 500 R the translocation frequency was about 100 times greater for stage 14 than for stage 7. In order to explain the great difference in sensitivity, differential restitution of radiation induced chromatid breaks together with differences in the spatial arrangement of the chromosomes in the two oocyte stages was assumed. For stage 14 the frequency of translocations obtained by irradiation with 100 R was significantly lower than that obtained by 500 R. The departure even from a linear dose-effect relationship was highly significant. It is suggested that the decrease of translocation frequency with increasing dose was caused by a close connection between the induction of autosomal translocations and dominant lethals. (auth)

28418 INDUCTION OF MUTATIONS IN BARLEY: RELATIVE EFFECTIVENESS OF GAMMA RAYS, ETHYL SULFATE, ETHYL METHANE SULFONATE, AND SOME OTHER SUBSTANCES. Heslot, H. (Institut National d'Agronomie, Paris); Ferrary, R.; Levy, R.; Monard, C. Oleagineux, 17: 537-9 (June 1962). (In French).

A large number of mutagenic sulfonic acid derivatives and γ radiation were tested on barley. The seeds were treated in the dry state by 25,000-R doses of γ rays or by soaking for 24 hr in solutions of the chemical agents. With radiation at this dose, sterility in the M_1 plants occurred in 20.4% compared with 1.9 to 63.7% with the sulfonic acid derivatives. Frequency of mutations was 5.0% with γ rays and 50.4% with a 1/100 dilution of ethyl methane sulfonate (EMS), the highest level attained with any of the chemical mutagens. The percentage of albino mutants was higher after γ irradiation (57.1%) than after treatment with sulfonates (47.9%, the highest value obtained, with 1/150 EMS solution). Analysis of the M_2 generation showed the percentage of chlorophyll mutants, morphologic mutants, and sterility to be 7.2, 0.7, and 4.2, respectively, for γ radiation; 31.3, 18.8, and 35.3 for EMS treatment; and 16.3, 10.0, and 22.2% for dimethyl sulfate treatment. (BBB)

28419 CELLULAR COMPOSITION OF HEMOPOIETIC SPLEEN COLONIES. Fowler, J. H.; Wu, A. M.; Till, J. E.; McCulloch, E. A.; Siminovitch, L. (Univ. of Toronto, Ontario Cancer Inst.). J. Cell. Physiol., 69: 65-72(Feb. 1967).

The cellular composition of individual hemopoietic spleen colonies from mice has been studied using techniques which tested primarily for cell function rather than cell morphology. Erythroblastic cells were recognized by their capacity to incorporate radioiron, granulocytic cells by their content of peroxidase-positive material, and hemopoietic stem cells by their ability to form spleen colonies in irradiated hosts. It was found that, 14 days after the initiation of spleen colonies, the distribution of these cell types among individual colonies was very heterogeneous, but that most colonies contained detectable numbers of erythroblasts, granulocytes and colony-forming cells. An appreciable proportion of the cells in the colonies could not be identified as any of these three cell types. No strong correlations between numbers of erythroblasts, granulocytes and colony-forming cells in individual colonies were observed, though there was a tendency for colonies containing a high proportion of erythroblasts to contain a low proportion of granulocytes, and for colonies containing a high proportion of granulocytes to contain a higher proportion of colony-forming cells. An analysis of colonies which contained cells bearing γ radiation-induced chromosomal markers indicated that 83 to 98% of the dividing cells within 14-day spleen colonies were derived from single precursors. (auth)

28420 THE OCCURRENCE OF CHROMOSOMAL ABERRATIONS IN PRE-SPERMATOCYTIC CELLS OF IRRADIATED MALE MICE. III. STERILITY AND SEMISTERILITY IN THE OFFSPRING OF MALE MICE IRRADIATED IN THE PRE-MEIOTIC AND POST-MEIOTIC STAGES OF SPERMATOGENESIS. Griffen, A. B.; Bunker, M. C. (Jackson Lab., Bar Harbor, Me.). Contract AT(30-1)-2113. Can. J. Genet. Cytol., 9: 163-254 (Mar. 1967).

Among the offspring of gonially x irradiated male mice, the bearers of major chromosome aberrations are detectable with great ease, since the affected individuals are characterized by obvious dominant sterility or semisterility. Throughout their reproductive lives gonially irradiated male mice transmit chromosome aberrations to their offspring. At both 350 R and 700 R the frequency of aberrant individuals among the offspring of gonially irradiated males tended to remain constant; therefore genetic changes induced in spermatogonia become permanently transmissible features of the irradiated testis. Among the offspring the sex ratios indicate greater genetic damage to X-bearing sperm than to Y-bearing sperm at the higher dosage. For both irradiation dosages sterility among F_1 females was excessive and was credited to causes other than inherited radiation damage. True dominant sterility was found among F_1 males; among sterile and semisterile males, detected cytological anomalies were present at about the same frequency. The detected cytological anomalies included translocations, deficiencies, trisomics, partial trisomics, interrupted meiosis, and abnormal Sertoli nuclei. In approximately one-third of the total semisterile individuals which were studied, cytologically, cytohistological anomalies were detected; similarly, in one-third of the total analyzed sterile individuals, anomalies were detected. In irradiated sperm, true dominant lethal changes are induced, causing zygotic or embryonic death and effectively reducing litter sizes. Litter-size reduction after gonial irradiation does not provide evidence of dominant lethality, but provides a means of detecting a portion of the total viable gonial aberrancies which otherwise could not be detected. At acute x-ray dosages of 350-700 R, a semisterility incidence of approximately 20% can be expected among mice which are derived from irradiated spermatids and spermatozoa. A semisterility incidence of approximately 5% can be expected among mice which are derived from irradiated spermatogonia. For irradiated spermatids and sperm the incidence of S males and SS males among offspring was approximately doubled when the dosage was doubled. It is suggested that the incidence curves will remain linear when data for other dosages have been accumulated for irradiated spermatids and sperm. For irradiated spermatogonia the incidence of S males among offspring was increased by only 25% when the dosage was doubled; and the incidence of SS males was actually lowered when the dosage was doubled, or showed inverse proportionality to the dosage. It is suggested that both of the incidence curves will show clear inverse proportionality when data for numerous other dosages have been accumulated. The generally unrecognized complexities attendant upon spermatogonial irradiation have been discussed, and an extensive diploid selection hypothesis has been proposed as a means of clarifying the elusive principles which are involved. It can be suggested that until these principles are understood and properly applied, perhaps with modifications which must always be expected when new concepts are propounded, attempts to evaluate gonial radiation damage will remain inconsequential. Because of complexities which have been discussed, the accurate formulation of either mutational or aberrational damage to spermatogonia is not yet feasible; meanwhile, the easily measurable frequency of sterility and semisterility among offspring provides ample proof that such damage is both extensive and permanent. (C.O.)

28421 A STUDY OF THE GENETIC PROCESSES IN IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. III. THE FECUNDITY AND THE CONCENTRATION OF LETHAL MUTATIONS. Bileva, D. S. (Moscow State Medical Inst.). Genetika, No. 4, 66-73(Apr. 1967). (In Russian).

A study of the effect of irradiation and population density on the fecundity (egg production per female per day) of fruit flies (Drosophila melanogaster) from the control and experimental populations was carried out. It was shown by this study that the effect of the density of population 30 × 30 and 50 × 50 reduces the fecundity not less considerably, than the irradiation by the dosages of 3000 R to 5000 R. The fecundity is determined virtually by that factor which limits it to a greater extent. At the population density

1 × 1 it is the irradiation. As the population density increases by 30–50 times, it is to a greater degree the shortage of food consumed per female. Consequently the difference in the fecundity between the control and the irradiated flies decreases with the increase of the population density. In the first generation of the progeny of irradiated flies the normal fecundity is completely recovered. It was shown by the investigation of the concentration of lethal and semilethal mutations in the control population and in that irradiated once (at a dosage of 5000 R) before and after the establishment of the equilibrium of the numbers of individuals, that in the control population it was low (10.67%) because this population was derived from an inbred line. In F_3 following the irradiation the concentration of lethals and semilethals increased up to 30.4%. However, after the equilibrium of the population was restored, the concentration decreased again to the level of the control population. (TSS)

28422 COMPARATIVE STUDIES IN THE RADIOSENSITIVITY AND MUTABILITY OF DIFFERENT PEA VARIETIES TREATED BY GAMMA-RAYS. Sidorova, K. K.; Kalinina, N. P.; Uzhintseva, L. P. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika, No. 4, 37-45(Apr. 1967). (In Russian).

Radiosensitivity and mutability in four pea varieties depending on their genotypical characteristics were studied. The dosages of γ-rays used were 5 and 10 kr. It was established that the radiosensitivity is largely dependent on the presence of the recessive factors r, com, t and le in the genotype. Different pea varieties in cases of the same frequency of chromosomal rearrangements differed in the percent survival of plants, which can be accounted for, to some extent, by the different capability of regeneration of tissues in these varieties. Hence it may be concluded that the frequency of chromosome rearrangements is not the only criterion of the sensitivity of a variety to irradiation. The survival of plants should be also taken into account. The comparison of the data on the frequency of the rearrangements of chromosomes in M_1 seedlings and of visible mutations selected in M_2 shows that varieties with an equal frequency of chromosomal rearrangements can differ from one another in the frequency of visible mutations. Thus, the total mutability of a variety can not be estimated from the frequency of chromosome rearrangements alone. It is necessary to record also all the visible mutations occurring in the varieties tested. (auth)

28423 SOME FEATURES OF CHROMOSOME ABERRATIONS IN BARLEY ASSOCIATED WITH THE TRANSPLANTATION OF IRRADIATED EMBRYOS. Smirnova, T. N. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 4, 160-3(Apr. 1967). (In Russian).

The effect of transplantation of x irradiated barley embryos on the frequency of chromosome aberrations in primary root meristematic cells was studied, the time of the onset of mitoses being recorded. It was found that the frequency of aberrations depends on the time of fixation. The transplantation of the embryo was observed to decrease the frequency of chromosomal aberrations as compared to the intact seeds, irrespective of whether the recipient endosperm was irradiated or not. The transplantation also changed the dynamics and the frequency of the occurrence of chromatid-type bridges. (auth)

28424 DEVELOPMENT OF EMBRYO AND ENDOSPERM PRODUCED AFTER IRRADIATION OF POLLEN IN TRADESCANTIA. Vassileva-Dryanovska, O. (Agricultural Coll. of Sweden, Uppsala). Hereditas, 55: 129-48(1966).

Tradescantia pollen was treated with x and γ radiations at doses of 1-500 kR. In the embryos acentric fragments in the cytoplasm and lobed nuclei were found, but no bridges. In the endosperm single or multiple dicentric bridges with acentric fragments, sticky aberrations with partial elimination of the male chromatin, and some instances of full elimination of the male chromatin at doses of 5 and 10 kR. The latter formed approximately diploid or aneuploid metaphases. Abnormalities increased with increasing doses. Haploid or near-haploid embryos were sometimes formed. These resulted from male chromatin elimination or mitotic abnormalities. Pollination with irradiated pollen produced seeds only at the 1 kR dose. (TID)

28425 RADIATION EFFECTS ON CELLULAR KINETICS. Frindel, E. (Gustave Roussy Inst., Villejuif, France). At. Energy Rev., 4: No. 3, 3-37(1966).

As a result of the advent of autoradiographic techniques it is now possible to study the cell cycle. Little is known about the biochemical process that initiates mitosis and DNA synthesis, and about the mechanism of mitotic delay induced by ionizing radiations. The radiosensitivity of cells in vitro and in vivo varies with the stage of the cell cycle at the time of radiation. The fluctuations in recuperation kinetics after fractionated doses of radiation are explained partly by cell recovery from sublethal damage and partly by cell movement through the cell cycle. The repair process is investigated indirectly by using different agents that are likely to inhibit this process. The effects of radiation on DNA synthesis are described in the light of recent interpretations which indicate indirect rather than direct effects on the biochemical process of DNA synthesis, and are explained in terms of cellular kinetics. (auth)

Health Physics and Safety

Refer also to abstracts 27928, 27995, 28042, 28045, 28338, 28339, 28347, 28407, 28411, 28518, 28591, and 29025.

28426 (ANL-7291) RADIATION SAFETY TECHNICIAN TRAINING COURSE. Moe, H. J.; Lasuk, S. R.; Schumacher, M. C. (Argonne National Lab., Ill.). Sept. 1966. Contract W-31-109-eng-38. 359p. Dep. CFSTI.

This report supersedes ANL-6991.

Lectures prepared for a training course for radiation safety technicians are presented. Topics discussed include basic information on radiation, natural radioactivity, properties of radiations, radiation units and dose determinations, shielding, biological effects of radiation, background radiation, radiation protection standards, internal dose calculations, radiation detection principles, operating characteristics of radiation detectors, radiation survey instruments, personnel monitoring devices, air sampling methods, and the design characteristics and radiation protection problems of reactors, hot cells, and particle accelerators. (38 references.) (C.H.)

28427 (BNWL-335(Rev.)) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, SEPTEMBER 1966, ON AEC DIVISION OF BIOLOGY AND MEDICINE PROGRAMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1966. Contract AT(45-1)-1830. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

ZINC-65 — uptake by freshwater mussels
STRONTIUM-90 — effects of chronically ingested, on swine
X RADIATION — effects on lipid content of rat lungs
PLUTONIUM-238 — distribution of ingested microspheres of plutonium oxide containing, in swine; effects on pathology of dog lungs from deposited microspheres, of plutonium oxide
METHIONINE — effects on RNA synthesis by Escherichia coli
TRYPTOPHAN — metabolism in Neurospora crassa
MAN — cesium-137 content in, residing in Alaska, whole-body, 1966
LICHENS — cesium-137 in, sampled in Alaska, 1966
CESIUM-137 — content in mountain bog plants; uptake by roots of barley plants, from soil surface
CHRONIUM-51, IRON-59, ZINC-65 — content in aquatic organisms in Columbia River, effects of reactor effluent on
FALLOUT — distribution in atmosphere, mechanisms of; distribution in precipitation mechanisms of
GAMMA SPECTROMETERS — performance for measurements of fallout activity in air filter samples
RICHLAND AREA (WASH.) — aerial surveying of, using infrared imaging equipment to determine thermal distribution over land and water areas (C.H.)

28428 (BNWL-SA-1247) THEORETICAL EXCRETION OF PLUTONIUM IN URINE BASED ON THE NEW ICRP LUNG MODEL. Nelson, Iral C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 9, 1967. Contract AT(45-1)-1830 29p. (CONF-670521-3). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

The new International Radiological Protection Commission (ICRP) lung model describes the deposition and clearance of various radionuclides as a function of particle size parameters. Taking the material cleared from the lung to blood and applying the methods of Langham and Healy, estimates of the systemic and lung burdens of plutonium are developed from several situations. Practical applications of the model to accidental inhalation of plutonium are considered. (auth)

28429 (BNWL-SA-1259) THE EFFECTS OF SUBSTRATE CONDITIONS ON THE UPTAKE RATE OF ^{137}Cs BY PLANTS. Cline, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 12, 1967. Contract AT(45-1)-1830. 16p. (CONF-670503-5). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Plants from marshy areas accumulate more ^{137}Cs than do plants growing in nonflooded terrain. This higher accumulation in plant tissue has been explained by direct uptake of the ^{137}Cs by the roots prior to any attachment of the radionuclide to the soil colloid. The present study shows that ^{137}Cs moves freely from soil colloids to roots when both are suspended in turbulent nutrient solution. Drying the contaminated clay at 100°C prior to suspending it in the

nutrient solution did not decrease the rate of uptake by the plants, and this rate of accumulation was the same as in plants grown in solution with ^{137}Cs added as the ion. Leaf-substrate ratios were 25 to 50 times higher in plants in nutrient solution than in plants growing in a soil substrate with no turbulent movement between the ^{137}Cs soil particle and the root absorbing surface. (auth)

28430 (BNWL-SA-1261) THE DETERMINATION OF THE DEPTH AND AMOUNT OF ^{239}Pu IN WOUNDS WITH Si(Li) DETECTORS. Palmer, H. E.; Wogman, N. A.; Cooper, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 15, 1967. Contract AT(45-1)-1830. 17p. (CONF-670521-4; CONF-670610-1). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

From 12th Annual Meeting of the Health Physics Society, Washington, D. C.

A method was developed for defining the average depth of ^{239}Pu in wounds by x-ray spectrometry using a lithium drifted silicon detector. Lithium drifted silicon detectors are now available which, with appropriate electronics and when cooled to liquid nitrogen temperature, give a resolution of less than 1 keV for the full width at half maximum for x rays with energies down to about 3 keV. The 3 low energy X-rays, 13, 17, and 20 keV, associated with the decay of ^{239}Pu are well resolved with the Si(Li) detectors. The attenuation of 13 keV x ray in tissue is about three times greater than that of the 20 keV x ray, therefore, the relative counting rates of these two photons define the depth of a point source or the average depth of a spread source in the wound. The ratio of these counting rates is also a function of the self-absorption of a ^{239}Pu particle which may be embedded in the wound. This ratio can be used to correct an observed counting rate to that of a point source that does not undergo any absorption and provides a more accurate estimate of the ^{239}Pu in the wound. Plutonium-239 always contains some ^{241}Am, 60 and 26 keV photons. The relative attenuation of these high energy photons along with those of ^{239}Pu allows similar measurements at all depths within the human body. The use of this method on actual Pu wound cases is described. (auth)

28431 (DASA-1860) THE RELATIONSHIP BETWEEN SELECTED BLAST-WAVE PARAMETERS AND THE RESPONSE OF MAMMALS EXPOSED TO AIR BLAST. Technical Progress Report. Richmond, Donald R.; Damon, Edward G.; Fletcher, E. Royce; Bowen, I. Gerald; White, Clayton S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1966. Contract DA-49-146-XZ-372. 38p. Dep. CFSTI.

Shock tubes and high explosives were used to produce blast waves of various pressure-time patterns in order to study their biological effects. Data obtained from these experiments showed that, against a reflecting surface, the LD_{50} reflected pressure for any given species remained fairly constant at the longer time durations and then rose sharply at the shorter times. For dogs and goats, long durations were beyond 20 msec and for mice, rats, guinea pigs, and rabbits, beyond 1 to 3 msec. At the shorter durations, response depended to a great extent on the impulse, and on peak pressure for the longer pulses. Higher reflected pressures were withstood if animals were located beyond a certain distance from the reflecting surface where they received the incident and reflected pressures in two steps, separated by a given time-interval. In freestream exposures to air blast, orientation was significant. Animals suspended vertically or prone-side-on showed a lower tolerance to blast waves of a given intensity or at a given range than those end-on because the dynamic pressure appeared to add to their side-on pressure dose. Except for eardrum rupture and sinus hemorrhage, animals exhibited a remarkable tolerance to slow rising blast pressures without the presence of shock fronts. The lungs are considered the critical target organs in blast effects studies. The release of air bubbles from disrupted alveoli of the lungs into the vascular system probably accounted for the rapid deaths. The degree of lung hemorrhage was related to both the blast dose and the increase in lung weight over control values. For larger animals, the threshold for petechial hemorrhage was near 10 to 15 psi at long durations and 30 to 35 psi for pulses of 5 msec. At LD_{50} values lung weights were two to four times normal. Ear injury was not systematically studied; however, data gleaned from lethality and lung-injury experiments indicated that: eardrum response to blast pressures is subject to wide variation; a duration effect was observed in sheep, with 38-percent rupture recorded at 21.4 psi for durations near 100 msec versus no eardrum rupture at 32.4 psi when the durations were about 5 msec; and the severity of ear damage increased with the intensity of the blast. From the presented data, tentative estimations of man's response to fast-rising pressures of 3-msec duration were compiled. Pressures for threshold and severe lung-hemorrhage levels were 30 to 40 and above 80 psi, respectively. The threshold for lethality was 100 to 120 psi with and LD_{50} range of 130 to 180 psi. Time-honored estimates for human eardrum rupture values of 5 and 15 psi, respectively, for threshold and 50-percent could not be revised at this time. The estimates were given in terms of maximal effective pressures, which may be received from the incident, incident plus dynamic, or reflected pressure, dependent on orientation. For an individual against a reflecting surface that is normal to the incident shock, or prone with the charge detonated overhead, the maximal effective dose is the reflected pressure. If, however, the man is standing a few feet from this same reflecting surface or directly below the charge, he is subjected to pressures that rise in two steps; whereas, in the former situation, the maximal effective pressure would probably be the incident plus the dynamic pressures in the first step and, in the latter, only the side-on incident pressure in the initial step. The exact distance from a reflecting surface where the effective pressure changes from the reflected to incident, or incident plus dynamic, cannot be stated for man at this time. For personnel standing or prone-side-on to the charge when it is detonated at or near the surface, the side-on incident plus dynamic pressures become the effective pressure; however, with orientations end-on in this situation, only the side-on incident pressure appears to be the maximal effective pressure. (auth)

28432 (EUR-3069.f) NIVEAUX DE CONTAMINATION RADIOACTIVE DU MILIEU AMBIANT ET DE LA CHAINE ALIMENTAIRE. Rapport Annuel, 1965. (Radioactive Contamination Levels in the Environment and in the Food Chain. Annual Report, 1965). Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 8, 1966. 49p. (In French). Dep. mn.

In 1965 the EURATOM-C.E.A. association continued research with the aim of establishing radiation protection levels. In human biology the study of the fate of ingested particles in the gastro-intestinal tract, and the study of ^{131}I uptake by infants are almost complete. The study of ^{90}Sr metabolism during growth was begun. The anatomical analysis of the European man during growth was begun in 1962 and 1963 and was resumed in order to obtain more complete data. The evaluation of data from dietary questionnaires in 11 regions of the communities continues. It was possible to determine the mean individual consumption of foods in each region; the estimation of the food consumption of various age groups is being made. A study of the transfer of radioactive contamination from the environment to food products was an important part of the activity of the association in 1965. It included both overall studies based on the interpretation of monitoring measurements and analytical studies of the transfer of contamination from the atmosphere to products of vegetable and animal origin, the soil, and water. The effects of radiation processing on radioactivity in foods were also studied. (tr-auth)

28433 (EUR-3179.d) LITERATURSTUDIE UEBER PROBLEME DER DEKONTAMINATION VON GETREIDE UND GETREIDEERZEUGNISSEN. (Literature Study of Problems Relating to the Decontamination of Cereals and Cereal Products). Ocker, H. D.; Muehlening, M.; Zwingelberg, H. (Bundesforschungsanstalt fuer Getreideverarbeitung, Detmold (West Germany)). Nov. 3, 1966. 30p. (In German). Dep.

The aim of the present study on the problems of decontaminating radioactively contaminated grain was to collect and evaluate the available published data in order to elucidate the present situation as regards the possibilities and processes for decontaminating large batches of grain and grain products. Emphasis is placed on those methods which are most suitable from the technical and economic viewpoints, or would offer the best prospects after appropriate further development. In the light of the investigations conducted to date, the following principles merit consideration: cleaning, washing, shelling, peeling, husking, and grinding. (auth)

28434 (EUR-3274.e) STUDIES ON THE RADIOACTIVE CONTAMINATION OF THE SEA. Annual Report, 1965. Bernhard, M. (Comitato Nazionale per l'Energia Nucleare, La Spezia (Italy). Laboratorio per lo Studio della Contaminazione Radioattiva del Mare). Apr. 1967. 33p. (RT/BIO-(66)28).

Progress is reported on a study of the factors which influence the uptake, accumulation, and loss of radioisotopes by marine organisms. A survey of the elements and factors in a sampling area is presented. Data are presented from studies carried out during 1965 on the influence of environmental factors on the uptake, accumulation, and loss of ^{65}Zn in algae and a number of zooplankton organisms. Data on the chemical composition of mussels (mytilus) are included. (C.H.)

28435 (IAN-RS-ERA-1) ESTUDIO RADIOMETRICO AMBIENTAL DE LA SABANA DE BOGOTA. (Radiometric Survey of the Sabanna Around Bogota). Ahumada B., J. (Instituto de Asuntos Nucleares, Bogota (Colombia). Seccion de Radiofisica Sanitaria). Aug. 1963. 55p. (In Spanish). Dep.

The sampling, preparation, and counting of the α and β-γ activity from fallout of air samples and rainwater taken at the Instituto de Asuntos Nucleares, Bogota, Colombia, and at other specified sites for the periods between September 1961 and December 1962 are described. The techniques and the detection devices used are described. The experimental data obtained is reported in tables and graphs and discussed. (J.S.R.)

28436 (IAN-SR-1) REGLAMENTO DE SEGURIDAD RADIOLOGICA. (Regulations for Radiological Safety). Toro, J.; Guzman, M. (Instituto de Asuntos Nucleares, Bogota (Colombia). Division de Radiofisica Sanitaria). Dec. 1964. 62p. (In Spanish). Dep.

Radiological safety regulations designed to protect the population in general, persons working with radioactive materials particularly, and specifically workers of the Instituto de Asuntos Nucleares are compiled. The regulations are based on the recommendations of the International Agency of Atomic Energy and the manual of the National Bureau of Standards. (J.S.R.)

28437 (LFEN-55) PROTECCAO CONTRA RADIACOES EM PORTUGAL. (Radiation Protection in Portugal). Cacho, Carlos; Galvao, Julio Pistacchini; Raposo, Joao Simoes (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1966. 14p. (In Portuguese). (CONF-650986-2). Dep.

From 10th Brazilian and 1st Portuguese Congress on Radiology, Rio de Janeiro, Brazil.

The development in Portugal of radiation protection standards and the organization of official bodies to supervise the radiation protection standards adopted are briefly reviewed. (J.S.R.)

28438 (NCRP-32) RADIATION PROTECTION IN EDUCATIONAL INSTITUTIONS. (National Council on Radiation Protection and Measurements, Washington, D. C.). July 1, 1966. 63p. NCRP Publications, Washington, D. C. $0.75.

Recommendations of the National Council on Radiation Protection and Measurements concerning radiation protection during the use of radiation sources in educational institutions are presented. Emphasis is placed on the protection of both students and teachers when radiation sources are used for demonstrations and experiments at the high school and under-graduate college level. (C.H.)

28439 (NP-16726) CIVIL DEFENSE COMMUNICATIONS REQUIREMENTS AT THE LOCAL, STATE, AND REGIONAL LEVELS. Final Report. Thayer, Sanford B.; Self, Charles R.; Burco, Robert A.; Tiffany, Willard D. (Stanford Research Inst., Menlo Park, Calif.). July 1966. Contract OCD-PS-64-201. 174p.

The study emphasizes the analysis of information and the derivation of circuit requirements for local, state, and regional civil defense operations during a nuclear emergency. Information flows between federal agencies and departments and within state agencies that are not assigned civil defense energency roles are excluded. The study approach is based on a narrative scenario of a generalized nuclear emergency situation and the actions undertaken by the various functional groups (fire protection, health, law and order, shelter management, etc.) in reacting to the demands of the emergency. The information flows required between various functional groups and levels of government are abstracted from the scenario and classified by means of a number of descriptors (urgency, frequency, volume of messages). Thus the need for, and nature of, communication links is ascertained. From this analysis, requirements for communication links are translated into circuit requirements; these can serve as a basis for the engineering design of communications systems and the selection of equipment. A companion SRI report, Communications Equipments and Systems To Support Intrastate Civil Defense Operations— Circa 1960, by Cone, Baer, and Shapiro treats the engineering issues. The most significant conclusion of the study is that a detailed statement of communication requirements in support of civil defense cannot precede a clear-cut description of the organization itself. Further, the procedures and policies that govern an organization also govern the nature and volume of information flows supporting it. (auth)

28440 (NYO-3364-19(Rev.)) RADIATION EXPOSURE OF THE GONADS DURING BETATRON THERAPY AT 31 MeV. Stroemme, Aksel (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). [1965]. Contract AT(30-1)-3364. 6p. (NYO-3364-33). Dep. CFSTI.

The doses to the gonads after betatron treatment at 31 MeV to a thorax field were measured and compared with the doses after treatment with 200 KeV Roentgen rays. The results are discussed with regard to the contribution from the radiation head and annihilation radiation from induced radioactive isotopes. (auth)

28441 (RA-14) DE RADIOACTIVITEIT VAN WATER, SLIB EN ZWEVENDE STOF VAN DE RIJN IN NEDERLAND. RAPPORT BETREFFENDE METINGEN, UITGEVOERD TEN BEHOEVE VAN EURATOM IN HET KADER VAN HET ONDERZOEK NAAR DE RADIOACTIVITEIT IN HET RIJNBEKKEN. (The Radioactivity of Water, Slime, and Floating Material of the Rhine in the Netherlands. Report Concerning Measurements Issued on Behalf of Euratom in the Framework of the Investigation of the Radioactivity in the Rhine Basin). de Regt, H. B. (Rijks Instituut voor Zuivering van Afvalwater, Voorburg (Netherlands)); Mattern, F. C. M. (Rijks Instituut voor de Volksgezondheid, Utrecht (Netherlands)). Apr. 1965. 65p. (In Dutch). Dep. mn.

The results of radioactivity measurements on water, slime, and floating matter in the Rhine in the Netherlands are reported. The highest concentrations of α and β emitters were found in the slime. The maximum α was found in autumn whereas the maximum β and γ was found in the spring. There was no relation between the activity and the annual variation of the slime. (tr-auth)

28442 (RA-23) RADIOACTIVITY IN SURFACE-WATER AND PRECIPITATION. MEASUREMENTS DURING 1964. (Rijks Instituut voor de Volksgezondheid, Utrecht (Netherlands)). 24p.

Results of measurements of gross alpha activity, gross beta activity, ^{90}Sr (^{89}Sr), ^{144}Ce, and ^{226}Ra in water of the rivers Rhine, Roer, and Meuse and the lake of Loenerveen are summarized. Measurements of gross alpha activity, gross beta activity ^{90}Sr (^{89}Sr), ^{144}Ce, and ^{137}Cs in rainwater, collected at Bilthoven (province of Utrecht) are reported. No discussion of results is given. (auth)

28443 (RA-27) BETREFFENDE ^{89}Sr, ^{90}Sr, EN ^{137}Cs IN DE VOEDING IN NEDERLAND. MEETRESULTATEN IN HET JAAR 1965. (Concerning ^{89}Sr, ^{90}Sr, and ^{137}Cs in the Foodstuff in the Netherlands. Measurement Results in the Year 1965). Mattern, F. C. M.; Strackee, L. (Rijks Instituut voor de Volksgezondheid, Utrecht (Netherlands)). Apr. 1966. 25p. (In Dutch). Dep. mn.

The results of the measurement of ^{89}Sr, ^{90}Sr, and ^{137}Cs in milk, cheese, flour, vegetables, fruit, potatoes, meat, eggs, and drinking water in the Netherlands in 1965 are tabulated. The mean uptake was estimated at 24.5 pCi of ^{90}Sr and 160 pCi of ^{137}Cs per day per person. (J.S.R.)

28444 (RT/PROT-(66)26) STIMA DELLA PERICOLOSITA DELLE RICADUTE RADIOATTIVE (FALLOUT) PER INALAZIONE DEI PRODOTTI DI FISSIONE. (Hazards From Inhalation of Fallout Fission Products). Breuer, F.; Rienzo, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 25p. (In Italian). Dep.

A calculation method is described for the evaluation of the hazard from inhalation of air contaminated by fission products released in nuclear tests. The hazard is expressed by a percent index, which is calculated with sufficient conservative criteria to meet the requirements of health protection. The total activity concentration and the single concentrations of a given number of nuclides (in pCi/m^3) must be known for the application of the method. Besides the general calculation formula for the index, other particular formulas were elaborated to make the use of the method in different situations easier. (auth)

28445 (SZS-14/66) [MONITORING OF RADIOACTIVE AIR AND WATER]. Ullmann, W.; Maiwald, E.; Przyborowski, S.; Herrmann, Dieter B. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Dec. 1966. 38p. (In German). Dep.

In laboratories of classes I and II a continuous control of radioactivity in air is necessary during operations with unsealed radioactive materials. The relevant laws and common methods of measurement are briefly reported. The actual situation is estimated and the design of a small apparatus for integral detection of β-active aerosols proposed by the Radiation Protection Center is discussed. (auth)

28446 (UCRL-70292) RESIDUAL TRITIUM AT SEDAN CRATER. Koranda, John J. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 2, 1967. Contract W-7405-eng-48. 36p. (CONF-670503-9). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Residual tritium from the Sedan thermonuclear detonation, 6 July 1962, was scavenged by or entrained in the 5 to 6 million tons of earth materials moved by the detonation. As a result, the Sedan post-shot environment contained a most significant biological tracer in the form of THO. Residual tritium (THO) is found in μCi concentrations in the interstitial water of the Sedan throwout soil, and in the loose tissue water of plants that have re-invaded the new substratum deposited on the landscape adjacent to the crater. Tritium is present not only in the loose tissue water of vascular plants growing on the Sedan throwout, but a comparable level is also found in the tissue-bound hydrogen of these plants. Herbivores, mainly heteromyid rodents, which

have re-invaded the Sedan post-shot environment and reside there, also have tritium concentrations in their body water between 1 and 3 μCi/ml. These body-water tritium concentrations are closely related to the levels of tritium in the plant tissue-bound hydrogen. Soil-water tritium concentrations in the soil air at the rodent burrow depth are several orders of magnitude lower than the observed body-water level. The inspirational route of entry of tritium into the animal is therefore assumed to be a secondary one, with the primary source being the plant organic matter synthesized in the Sedan post-shot environment which is used as the animal's food base. The internal dose to the resident mammal at Sedan Crater from residual tritium is estimated to be between 18 and 268 rad, or about 10 times that from external radiation sources resulting from the detonation. (auth)

28447 (USNRDL-TRC-76) SUMMARY OF RADIOLOGICAL TARGET ANALYSIS PROCEDURES FOR DECONTAMINATION SCHEDULING. Lee, Hong (Stanford Research Inst., Menlo Park, Calif.). Apr. 1967. Contract N0022866C0231. 44p. CFSTI.

This report summarizes the research findings contained in four reports produced to date from radiological target analysis procedures development research. Mathematical equations for obtaining residual numbers for the purpose of selecting countermeasure options and for scheduling decontamination operations are reviewed and correlated. A stepwise procedure for applying the resulting residual numbers to scheduling decontamination operations within a limiting exposure dose is presented. The findings from exercising the mathematical equations according to the proposed procedures are used to define the utility of decontamination as a radiological countermeasure with respect to existing and proposed shelter systems. The range of fallout intensities where decontamination would be potentially useful is found to increase with better shelter systems and later fallout arrival times. (auth)

28448 USPHS DRINKING WATER STANDARDS OFFICIALLY APPROVED. J. Amer. Water Works Ass., 54: 1548(1962).

Portions of revised version of the U. S. Public Health Service Drinking Water Standards applicable to radioactivity in water are given. Approval of water supplies containing radioactive materials shall be based upon the judgment that the radioactivity intake from such water supplies when added to that from all other sources is not likely to result in an intake greater than the radiation protection guidance recommended by the Federal Radiation Council. Water supplies shall be approved without further consideration of other sources of radioactivity intake of ^{226}Ra and ^{90}Sr when the water contains these substances in amounts not exceeding 3 and 10 μμCi/l, respectively. When these concentrations are exceeded, a water supply shall be approved by the certifying authority if surveillance of total intakes of radioactivity from all sources indicates that such intakes are within the limits recommended by the Federal Radiation Council for control action. In the known absence of ^{90}Sr and α emitters, the water supply is acceptable when the gross β concentrations do not exceed 1000 μμCi/l. Gross concentrations in excess of 1000 μμCi/l shall be grounds for rejection of supply except when more complete analyses indicate that concentrations of nuclides are not likely to cause exposures greater than that recommended by the Council. (BBB)

28449 PHOTOGRAPHIC FILM FOR DETERMINATION OF ISODOSE CURVES FROM BETATRON ELECTRON RADIATION. Hettinger, G.; Svensson, H. (Univ. of Umea, Sweden). Acta Radiol., Therapy, Phys., Biol., 6: 74-80(Feb. 1967).

The use of photographic film exposed in a polystyrene phantom for the determination of depth dose and isodose curves from 10-35 MeV electron radiation is described. The technique is especially valuable in connection with an automatic isodensity writer. (auth)

28450 DISTRIBUTION CALCULATION OF ABSORBED GAMMA-RADIATION DOSES IN TISSULAR SURFACE LAYERS. Lur'e, A. I. (Inst. of Ministry of Public Health, USSR). Med. Radiol., 12: No. 4, 67-71(Apr. 1967). (In Russian).

Deduction of a formula for calculation of absorbed doses both in conditions of an electron equilibrium and in those when such an equilibrium is lacking. By analyzing the deduced formulas expressions are presented which help to calculate a dose on the surface of an irradiated substance and to estimate the depth at which maximum of the absorbed dose is achieved. Under discussion are relations existing between the mentioned above figures and the radiation energy, type of the source, distance between the source and the skin, filter and the irradiated area. Results of some calculations according to deduced proportions for a tissue-equivalent medium are reported. (tr-auth)

28451 ^{210}Po: REMOVAL FROM SMOKE BY RESIN FILTERS. Bretthauer, Erich W.; Black, Stuart C. (Southwestern Radiological Health Lab., Las Vegas, Nev.). Science, 156: 1375-6 (June 9, 1967).

Use of a mixed ion-exchange resin as a filter for cigarettes markedly reduced both the total amount of polonium-210 in mainstream smoke and the picocuries per milligram of smoke. The procedure effectively minimized exposure of the lungs of smokers to alpha irradiation. (auth)

28452 USE OF MULTIFIELD PHOTOCASSETTES FOR INDIVIDUAL DOSIMETRY IN X-RAY ROOMS. Videnskii, V. G.; Petrovskaya, G. A. (Inst. of Medical Radiology, Moscow). Med. Radiol., 12: No. 4, 72-4(Apr. 1967). (In Russian).

The employment of multifield photocassettes for determining individual irradiation doses for workers of x ray rooms are discussed. It is shown that the irradiation of a roentgenologist is mainly due to scattered X radiation and a definite energy was determined for this radiation. Two variants of graduation have been elaborated: by the roentgen radiation and by gamma radiation of ^{60}Co. It was disclosed that during the use of individual protection measures the irradiation level among workers of x ray rooms is significantly below the maximal permissible levels and lies within the limits of 10-100 mr per month. (tr-auth)

28453 THE NATIONAL RADIATION ADVISORY COMMITTEE. Report to the Prime Minister. Austral. J. Sci., 29: 59-72(Sept. 1966).

The fifth report of the National Radiation Advisory Committee of Australia is presented. Included in the report are reviews and brief outlines of current scientific knowledge on the effects of ionizing radiation on man; the revisions and confirmations of radiation protection standards and guides; the means for minimizing the degree of radiation exposure incurred in mass miniature x ray surveys, for the early detection of tuberculosis; the methods for safe and permanent disposal of radioactive wastes; and the study of the precautions that are to be observed in relation to visits by nuclear powered vessels. The nature of radioactive fallout from nuclear weapons tests and the possible consequences to the population were dealt with in considerable detail; the overall fallout situation in relation to current data is reassessed and discussed. (B.H.S.)

28454 A SIMPLE PROCEDURE FOR ESTIMATING OFF-AXIS DOSES IN A MEDIUM IRRADIATED BY ^{60}Co BEAMS. Tsien, K. C.; Wright, D. J.; Chou, Chao-chin (Temple Univ., Philadelphia). Radiology, 88: 967-72(May 1967).

Instead of employing isodose curves or scatter functions, a simple procedure was developed with minimum experimental data to estimate the dose at any point in an irradiated medium by simple calculation on the basis of constant dose-ratio lines. The required data for a cobalt-60 beam with 1 cm diameter source size covering a range of field sizes at 50 cm source-surface distance are presented here in a compact table for use as a supplement to the central-axis depth-dose table, or as the input data for computers. Off-axis dose ratios at any point with reference to the central-axis dose are obtainable by simple interpolation of data derived from this table. (auth)

28455 RADIATION DISTRIBUTION FOR 2 MVCp X-RAY GENERATORS BY DIGITAL COMPUTERS. Maduell, Charles R.; Hidalgo, John U. (Tulane Univ., New Orleans). Radiology, 88: 973-5(May 1967).

Radiation distributions for isodose curves as computed by the method of Meredith and Neary, as modified by Quimby et al., have been programmed for the IBM 1410 and IBM 7044 digital computers. Results on trial runs with orthovoltage were successful. Radiation distributions were generated for the most applicable field sizes for 2 MVCp x-ray generators. Comparison of the computed distributions with measured values indicates the validity of the method. (auth)

28456 OPEN-END LEAD-LINED DENTAL X-RAY CONES. Calvert, Keith; Carmichael, Cary (Univ. of Alabama, Birmingham). Oral Surg., Oral Med., Oral Pathol., 23: 328-34(Mar. 1967).

The extent of unnecessary radiation exposure of patients during dental radiography with various types of cones used with dental x-ray machines was evaluated by film dosimetry studies. It was found that the lining of open-end cones with 0.3-mm lead foil absorbs secondary radiation from the filter and stray primary radiation from within the tube head. It prevents scattering of secondary radiation produced in the plastic of the cone. Pointed plastic cones are contraindicated unless the diagnostic yield can be shown to exceed that of open-end cones. Lead-lined open-end cones appear to be essential if the patient is to be fully protected from unnecessary radiation. These experiments demonstrated that radiation reaches the skin of the patient's face and other portions of the patient's body as a result of failure of dentists to line dental x-ray cones adequately. Any radiation not specifically useful for diagnostic purposes should be eliminated. In addition to using other patient-protection methods, the dental

profession and manufacturers of dental x-ray machines should provide cones lined or impregnated with a suitable radiation absorber. Lead appears to be the best material. (BBB)

28457 INVESTIGATIONS ON THE SORPTION OF STRONTIUM IN SCHLESWIG-HOLSTEIN SOILS. Graf v. Reichenbach, H. (Christian-Albrechts-Univ., Kiel); Freiherr v. d. Bussche, G. Z. Pflanzenernaehr. Dueng. Bodenk., 101: 24-33(Apr. 1963). (In German).

The distribution of small additions of Sr, as ^{90}Sr, in water-soluble, exchangeable, and nonexchangeable forms was investigated in 165 samples of Schleswig-Holstein soils and its relation to soil properties such as exchange capacity, pH value, and clay and carbon content was determined using multiple regressions. Under the conditions in soil used, the water-soluble fraction of the added Sr was small. Strontium was thus retained in the top few cm of the soil, almost independently of the soil properties. The displacing action of percolation, caused by precipitation, was therefore small. Part of the Sr was transformed into the nonexchangeable form. The amount of the nonexchangeable fraction was dependent on soil properties, especially on the nature of the exchange features in the soil. With increasing carbon and humus content and exchange capacity, the non-exchangeable fraction of Sr increased. With decreasing clay content and pH value, it increased to a smaller extent. The significance of these results is discussed with regard to Sr available to plants. (BBB)

28458 EFFECT OF VARIOUS CATIONS UPON ABSORPTION OF CARRIER-FREE CESIUM. Handley, Raymond; Overstreet, Roy (Univ. of California, Berkeley). Plant Physiol., 36: 66-9 (Jan. 1961).

Studies relevant to fallout radiocesium uptake by plant roots were conducted with carrier-free ^{137}Cs rather than with labeled Cs since the isotopes of Cs in fallout are essentially carrier-free and thus such experiments may have more practical significance. Moreover, trace amounts of an element often behave differently in biological systems from macro amounts. The effects of the monovalent cations K, Na, NH_4, Rb, Li, and Cs and of the divalent cations Ca, Mg, and Ba upon the absorption of ^{137}Cs by excised barley roots were investigated. In the concentration range of 0 to 0.10 meq/l, Na, Li, Ca, Ba, and Mg had essentially no depressant effect upon ^{137}Cs uptake whereas K, Rb, NH_4, and Cs were markedly effective. At higher concentrations all ions investigated inhibited the absorption of ^{137}Cs. The uptake of carrier-free ^{137}Cs was found to be strongly temperature dependent and is therefore largely the result of metabolic absorption rather than of diffusion and adsorption phenomena. In spite of this, the behavior of the ions studied in inhibiting uptake of ^{137}Cs parallels their behavior in respect to competition for exchange sites upon soil colloids. (BBB)

28459 GENETIC VARIATION IN A MEASURE OF AVOIDANCE LEARNING IN SWINE. Willham, R. L.; Cox, D. F.; Karas, G. G. (Iowa State Univ. of Science and Tech., Ames). J. Comp. Physiol. Psychol., 56: 294-7(1963).

Differences among individuals in response to avoidance learning situations are usually maximal when the average probability of avoidance is near ½. This average was realized in the 3rd set of 10 trials given 572 young swine. The purpose of this work was to measure the relative amount of variance that is of genetic origin in number of avoidances made by Ss in the 3rd set of 10 trials. Genetic variance was separated from other sources by using the correlation between numbers of avoidances made by related individuals. Nearly 50% of the variance among pigs belonging to relatively homogeneous groups was attributable to additively genetic causes. Clearly, differences among individuals for this measure of learning ability in swine are influenced by the heredity of the individuals. (auth)

28460 SIGNIFICANCE OF RADIONUCLIDE CONTAMINATION IN RUMINANTS. Bustad, L. K. (Battelle-Northwest, Richland, Wash.); McClellan, R. O.; Garner, R. J. pp 131-46 of Physiology of Digestion in the Ruminant. Washington, Butterworth Inc., 1965.

A review, with 62 references, is presented on various aspects of contamination of ruminants by radionuclides released by nuclear detonations, reactor accidents, or nuclear industry operation. Specific radioactive elements involved, their characteristics and behavior, and their probable route of entry into the animal and their transfer via animal products to man are considered. The effects of the important radionuclides on ruminants are discussed and categorized according to the area of the body irradiated. This is followed by a discussion of the significance of contaminated ruminants as a source of food for man and then examination of various methods of reducing the hazard to both animals and man. (TSS)

28461 LARGE-SCALE FIXED-BED ION-EXCHANGE SYSTEM FOR REMOVING ^{90}Sr FROM FLUID MILK. I. PROCESSING RESULTS. Sparling, E. M. (Producers Creamery Co., Springfield, Mo.); Baldi, E. J.; Marshall, R. O.; Heinemann, B.; Walter, H. E.; Fooks, Jack H. J. Dairy Sci., 50: 423-5(Mar. 1967).

The Beltsville pilot plant, previously described, was scaled up to be capable of processing 45,400 l of milk per 8 hr. The plant was fully automated, except for the re-use of regenerant. This fixed bed ion-exchange system for removing ^{90}Sr from fluid milk was operated over a period of 10 months, processing a total of 413,000 l of milk at flow rates of 5700 l/hr during an 8-hr run. No unusual processing problems were encountered. The plant was constructed of stainless steel and other approved materials, and in compliance with 3-A Standards where applicable. Processing conditions were based on data obtained at Beltsville for flow rates, pH adjustment, regenerant composition, and sanitation control. The processed milk, although organoleptically acceptable, was spray dried and utilized for animal feed. In the event that environmental contamination should exceed safe tolerances, this process is a feasible and practical means for substantially reducing the levels of ^{90}Sr in milk. (BBB)

28462 RADIATION EXPOSURE AND RADIATION PROTECTION IN THORACIC EXAMINATIONS. Pape, Rudolf (Wilhelminenspitals, Vienna). Wien. Med. Wochenschr., 115: 290-2 (Apr. 3, 1965). (In German).

Reports indicate that the average gonadal dose to the Hamburg population from thoracic x-ray examinations have been 0.06 mR for men and 0.12 for women. The dose administered during fluoroscopy varies with the exposure time, dark adaptation of the operator, light intensity, and brightness of the screen. The position of the gonads is also a factor that can vary rather widely in female children and adults, and thus affect the amounts of irradiation received from thoracic examinations. The distance between the location of the gonads and the edge of the irradiation field is the most important factor. This distance is much less in small children than in adults. Thin children 11 to 15 yr old generally receive the least gonadal irradiation. They receive possibly an average gonadal dose of 0.02 mR/examination. For adults at 70 kV with a viewing time of 2 min at 2.5 ma the gonad dose ranges from 1.5 to 3.2 mR. At 90 kV with a viewing time of 48 sec and at 0.25, 0.1, and 0.3 ma, the gonadal exposure dose ranges are 0.25 to 0.5 mR, 0.05 to 0.1 mR, and 0.03 to 0.05 mR. However, the natural environmental irradiation received may be as high as 0.3 mR/day. (BBB)

28463 REPORT ON THE PROGRESS OF THE NUTRITION COUNCIL IN 1963. Voeding, 25: 510-33(Oct. 15, 1964). (In Dutch).

Among various items in this report is a review of the standards for permissible levels of radioactive contamination of food in peacetime, made with the cooperation of the Netherlands Health Council. The commission is in agreement with the basic norms set by Euratom; the importance of milk as the source of fallout contamination in peacetime is stressed. No other dietary item is likely to cause contamination levels surpassing allowable doses if milk is maintained within controllable range, except for contamination from ^{137}Cs in meat. The nuclides ^{131}I, ^{90}Sr ^{89}Sr, and ^{137}Cs are of most importance in milk; no norms for uptake of these were established. Permissible doses were taken in agreement with the 1959 report of the International Commission on Radiological Protection, the second 1960 report to the Medical Research Council (London), and Staff Reports 1 and 2 of the Federal Radiation Council (Washington, 1960). The whole body is taken as the critical organ. Daily variation in exposure can cause an excess of the annual permissible dose. The maximum permissible gonad dose is 1.5 rem per 30 years, thyroid 0.5 rem per year, for the blood forming organs 0.167 rem per year. Permissible contamination levels for milk, averaged over a year, in pC/l, are: ^{131}I, 100; ^{90}Sr, 300; ^{89}Sr, 3000, and ^{137}Cs, 3000. (BBB)

28464 RADIOISOTOPES USED IN PHARMACY. I. IMPORTATION AND USE OF RADIOACTIVE SUBSTANCES. A SURVEY. Kaern, M. (National Health Service, Copenhagen). Dansk Tidsskr. Farm., 5: 185-93(Oct. 1961). (In Danish).

Danish regulations concerning acquisition and application of isotopes are outlined. Since 1953 importation and use of radioactive substances has been subjected to the control of the National Health Service, as stipulated by Act No. 94 of 31 March 1953 on the Use of Radioactive Substances, an Order of the same data concerning Exceptions from Act on Radioactive Substances, and an Order of 15 June 1955 concerning Safety Precautions during the use of radioactive substances. After application to the National Health Service 3 types of permission may be granted. Standing permission is granted to universities, other higher schools of learning, and similar scientific institutions, including radium users who maintain a highly qualified staff. Such a permission gives, under certain conditions, the right to unrestricted import and use of radioactive substances. Group permission is granted to specially qualified persons who use many different isotopes. Certain groups

of isotopes in stipulated quantities can be imported and used. Single permission is given for the use of only a few isotopes and only those isotopes in stipulated amounts which are specified in the permission may be used. Depending upon the isotopes and sp activities used, various requirements are established concerning the qualifications of the person in charge, the equipment and arrangement of the lab, storage, and disposal of radioactive waste. The field in which the radioactive substances are to be used and the extent to which they will be used are also taken into consideration. The necessary information is given on a form obtained from the National Health Service, and a new form is required for each application. The National Health Service is informed of all importations of radioactive substances. In 1961, 62 different isotopes, with a total activity of 174 Ci were used. The National Health Service, in collaboration with the Fire Department and the Inspectorate of Labor and Factories, inspects those institutions and factories where isotopes are used, and ensures that the rules stipulated by ICRP are complied with. (BBB)

28465 MAINTAINING PERSPECTIVE THROUGHOUT THE INVESTIGATION OF A LEAKING RADIOACTIVE GASEOUS TRANSCONTINENTAL SHIPMENT. Paas, Herman J. Jr. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 13: 543-7(June 1967).

The investigation and evaluation of a radiation incident involving leakage from a transcontinental shipment of radioactive methyl iodide are described. The actions required to minimize public impact across a 2500 mile route involving exposures to truckers, airline crews, passengers, air terminal employees, and laboratory employees at two locations are also discussed. Deposition of radioiodine was identified in the thyroids of fifty-nine people, including five in excess of recommended guide values. Of all those persons with known exposure, 75 per cent were examined for thyroid deposition. Coordination of monitoring capabilities in widely separated geographic areas, identifying personnel, obtaining thyroid measurements, working with press and television outlets, and utilizing the services of widely scattered professional disciplines, were among the many problems overcome in maintaining the radiological incident in perspective, one of the least important and less frequent of the many hazards in man's environment. (auth)

28466 RADIOACTIVITY IN CIVILIAN NORWEGIAN PILOTS. Hannisdahl, Birger (Scandinavian Airlines System, Oslo); Stromme, Aksel. Aerospace Med., 38: 521-2(May 1967).

A study of the cesium-137 body burder in a group of civilian Norwegian pilots of average height and weight and between the ages of 35 and 45 years was carried out over a three year period (1964 to 1966). In order to compare the results of the data obtained from the pilots with that of other groups of the population, three groups were selected: a group of adult men with characteristics similar to those of the pilots and from a community on the west coast of Norway where radioactive fallout was high; a group of men from Oslo who were younger than the pilots; and a group of school youngsters. The average concentrations of ^{137}Cs in the pilots were 44.9, 42.7, and 36.2 nCi for each of the respective years. A comparison of the data on the radioactive effects of the ^{137}Cs on the pilots and each group was made. Results showed that the effect on the pilots was about the same as that on the youngsters and men of Oslo and was much lower than that on the men from the west coast. It was concluded that flying at altitudes below 30,000 feet was not a risk as far as radioactive fallout was concerned. (B.H.S.)

28467 ENVIRONMENTAL RADIOLOGICAL MONITORING SYSTEM AT NUCLEAR INSTALLATIONS. Ishihara, Toyohide (Japan Atomic Energy Research Inst., Tokyo). Health Phys., 13: 549-58(June 1967).

A description is given of the theoretical analysis and design of an environmental monitoring system, for radioactive substances released into the atmosphere. This environmental monitoring system should be able to detect sudden large releases of radioactive materials soon enough to enable appropriate steps to be taken, and should also routinely measure the levels of hazardous nuclides. It should detect the levels of radiation and radioactivity before exposure of the populace around reached specified limits; this means that the higher the dose rate the earlier detection must occur. The results of investigations have shown that this monitoring system should function in the following three ways: centralized continuous automatic monitoring; regular surveys of the radiation levels; and environmental sample analysis. The selection of suitable biological indicators for the environmental contamination monitoring, and the development of measuring methods for low-level dose rates (e.g., 10^{-6} rad · hr^{-1}) are important in the design of an effective environmental monitoring system. Three different centralized continuous monitoring systems for nuclear installations are described. (auth)

28468 RADIATION DOSIMETRY OF THE ^{131}I-HIPPURAN RENOGRAM. Henk, J. M.; Cottrall, M. F.; Taylor, D. M. (Royal Marsden Hospital, Sutton, Eng. Inst. of Cancer Research, Sutton, Eng.). Brit. J. Radiol., 40: 327-34(May 1967).

Thirty patients have been studied by whole-body counting and thyroid uptake measurements following routine ^{131}I-Hippuran renography, and the radiation dose to the kidneys, thyroid, bladder wall and gonads calculated. Most of the activity retained in the body was contained in the thyroid gland and derived from free-iodide in the injected material. The thyroid dose was of the order of 1 rem; this could be reduced by a factor of 7-10 by blocking the thyroid or by the use of iodide-free Hippuran. The gonad dose was less than 2 mrem, about 1 per cent of that from an intravenous pyelogram. It is concluded that renography constituted a negligible radiation hazard to the patient. (auth)

28469 RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION FOR RADIATION PROTECTION. REPORT OF THE COMMITTEE II. PERMISSIBLE DOSE IN THE INCORPORATION OF RADIONUCLIDES. Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 27, 1-265(1966). (In German).

Basic standards for the maximum permissible radiation burden by incorporated radionuclides are outlined. The highest permissible values for professional radiation burden are given. The calculation of the maximum permissible value for the radiation burden is described. Factors necessary for the evaluation of the equations for the maximum permissible concentrations are defined. The values obtained are tabulated. (J.S.R.)

28470 STRONTIUM IN CALCITE: NEW ANALYSES. Nelson, Daniel J. (Oak Ridge National Lab., Tenn.). Publ. Inst. Mar. Sci., Univ. Tex., 10: 76-9(June 1965). (ORNL-P-333).

Calcite specimens from the Brush Mineralogical Laboratory, Yale University, were analyzed for Sr and Ca and were considered a reference material to resolve a difference in published values for Sr-Ca ratios in freshwater mollusks. The new analyses showed the earlier published Sr concentrations were high by as much as an order of magnitude. These new data extend the lower range of Sr-Ca ratios in naturally occurring calcium carbonate minerals to 0.0224 Sr atoms per 1000 Ca atoms. (auth)

28471 ESTIMATION OF PERSONAL NEUTRON DOSE IN NUCLEAR ACCIDENTS. Ohta, Yukiko (Tokyo Atomic Industry Research Lab.). Nippon Genshiryoku Gakkaishi, 9: 192-9(Apr. 1967). (In Japanese).

Information concerning personal neutron exposure doses was obtained for human hair, nails, and blood, with the view to determining a convenient method of detecting unexpected exposure. The most easily detectable nuclides in the hair were ^{24}Na, ^{56}Mn, ^{64}Cu, and ^{32}P. In case of serum, ^{24}Na was the element easily detected, while ^{24}Na, ^{56}Mn, ^{64}Cu, and ^{32}P were also found in the nails. The production of ^{32}P is the result of $^{32}S(n,p)^{32}P$ reaction with fast neutrons, while the other nuclides are mainly produced with thermal neutrons. The effect of competing reactions was found to be negligibly small. In order to know the content of each element in the human hair, nails, and blood, neutron activation determinations of ^{24}Na, ^{56}Mn, ^{64}Cu, ^{38}Cl, and ^{32}P were carried out. The detectable limits for 1 g of hair were 5 rem for thermal-neutron exposure and 60 rem for fast-neutron exposure. The result of this study shows that the hair is a useful detector for estimating the fast and thermal neutron exposure doses in the case of nuclear accident. (auth)

28472 RADIATION DANGER TO MAN. SECOND REPORT FOR THE MEDICAL RESEARCH COUNCIL OF GREAT BRITAIN. Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 28, 1-224(1966). (In German).

A German translation of the second report of the medical research council of Great Britain on radiation danger to man is presented. The various types of radiation and their biological effects are outlined. The radiation effect on the health of the individual is then considered. The genetic radiation effects and the present and future radiation burden are estimated. An evaluation is given of the danger of radiation burden. (J.S.R.)

28473 DOSE RATE OF γ RADIATION ABSORBED IN AIR. Mordashev, V. M. At. Energ. (USSR), 22: 133(Feb. 1967). (In Russian).

An approximation of the graphical display resulting from the calculation of the dose rate of γ radiation absorbed in air was given in the form of derivatives of the two functions: $P(E, \varphi, r) = P_0(E, r) \cdot k(\varphi, r)$ in the range $E = 0.208$ to 7950 eV, $\varphi = 15$ to 165°, and $r = 5$ to 30 m. The functions are graphed. (J.S.R.)

28474 TRANSFER OF HIGH-ACTIVITY γ RADIATION SOURCES. Hirling, Jozsef (National Atomic Energy Commission, Budapest). Atomtech. Tajek., 9: 547-65(1966). (In Hungarian).

High-activity γ radiation sources are being used at an increasing rate in agriculture, industry, medicine, and research. The most dangerous stage in their use is the transfer of the radioactive ^{60}Co or other source material from the container used for transportation into the irradiation facility of the hospital, laboratory, or plant. Since 1961, the Isotope Institute has assumed responsibility for installing high-activity sources; thirty such operations were carried out, and the highest activity handled amounted to 3200 Ci. Plans to extend this service to low-intensity sources are being made. All the known criteria and methods of radiation protection are used during the operation; they include such factors as distance, absorption by the ground, self-shielding of the container, special hot cells, remote manipulations, and use of water and lead shields. (auth)

28475 RADIATION HYGIENE AND PRACTICE IN DENTISTRY. J. Amer. Dent. Ass., 74: 1032-3(Apr. 1967).

The program of the American Dental Association to promote radiation hygiene is outlined. This program is concerned with the following topics: protection of the patient, including recommendations as to frequency of radiographic examination and use of protective coverings; protection of office personnel, including a discussion of shielding, radiation barriers, and monitoring services; guidelines for minimizing radiation exposure, including collimation, filtration, and other pertinent factors; exposure control factors, including timers, conversion technics, film speed, kilovoltage, and milliamperage; and visualization factors, including darkroom procedures and illumination technics. This report discusses frequency of radiographic examination in dental practice and the need for protective coverings for patient safety. Dental radiographic examinations should be made only when necessary for the patient's dental welfare, and such examinations should involve the minimum radiation necessary to form images with suitable sharpness and contrast for diagnostic purposes. The leaded apron may be used to protect against possible genetic damage through exposure to the gonads. However, the role of the apron in this respect is minor as compared with the benefit gained through use of high-speed film, a beam that is properly restricted by collimation and filtration, and an open-ended, properly shielded cone. (BBB)

28476 EXPOSURE OF MAN TO IONIZING RADIATION FROM NATURAL AND ARTIFICIAL SOURCES. Sievert, R. M.; Swedjemark, G. A.; Wilson, J. C. (Inst. of Radiophysics, Stockholm). pp 334-71 of Handbuch der Medizinischen Radiologie. Volume II. Part 2. Diethelm, L.; (and others), (eds.). Berlin, Springer-Verlag, 1966.

The extent of human exposure to natural and artificial sources of radiation is reviewed (80 references) with particular attention to the following topics: the nature and intensity of cosmic radiation, γ radiation levels at the earth's surface, natural radioelements in human body, exposure of man from natural internal and external sources, occupational exposure, exposure of the general public, exposure from medical sources and from fallout, comparison of doses and dose rates from various sources, significance of exposure from small doses and dose rates, and derivation of formulas for genetically significant dose. Evidence is presented that the biological effect of ionizing radiation depends to a large extent on the time-intensity distribution of the irradiation and not just on the total dose in a given time. Three possibilities are discussed for a greater (or in one case greater or smaller) effect of high than of low radiation intensity (dose-rate) during the period of the relevant biological process. The first is that the intensity as such may play an important role in the production of the biological effect. The second possibility is that a temporary high radiation intensity can coincide with a period when the biological system has an increased sensitivity. That part of the radiation received during the period of increased sensitivity may be decisive for the effect of the irradiation and a temporary high radiation intensity may in such a case cause an effect where the same dose given at low intensity would not. With large doses, such as those used in radiotherapy, there is a recovery effect so that a given dose has considerably less effect if spread out over a long period of time instead of being given within a short period. In this third possibility of a dependence on the radiation intensity, an intensity averaged over longer periods than in the other two cases is considered. (BBB)

28477 GONAD DOSE IN MALE MICE AFTER INCORPORATION OF ^{90}Sr. Mueller, W. A. (Biological Inst., Muenchen, Ger.). Nature, 214: 931-3(May 27, 1967).

Some studies are reported on gonad dose and its time course after intraperitoneal injection of ^{90}Sr (as chloride). The mean range of ^{90}Sr beta particles in tissue was taken as 0.42 mm., with a maximum range of 2.25 mm. The values for ^{90}Y daughter product were taken as 3.7 and 12.2 mm., respectively. Taking into account the small size of the laboratory animal the gonad dose may be composed of radiation emitted (a) from ^{90}Sr deposited in the gonads, (b) from ^{90}Y deposited in the gonads, by a separate pathway (c) from other body deposits, especially from the skeleton. Results are given for the course of dose rate with time in the gonad zone (after injection of ^{90}Sr), time course of Sr content in the testes (after injection of ^{85}Sr), time course of ^{90}Y activity in the testes, and activity in the skeleton after injection of ^{90}Sr. Miniature manganese-activated calcium fluoride luminescence dosimeters sewn into the scrotum were employed. The use of ^{85}Sr corresponded to injection of ^{90}Sr without daughter product. Amongst conclusions reached are that irradiation from the skeleton is only of secondary importance in connection with gonad dose; that yttrium moves into the gonads from other organs; that only about 12% of the gonad dose accumulated in 20 days is due to ^{90}Sr deposited in the gonads themselves, since the main part of the dose is induced by ^{90}Y selectively enriched in the gonads; and that in the combined system of ^{90}Sr and ^{90}Y the specific metabolic behavior of yttrium must be considered. It is stated that the results may help to explain observations of the mutagenic effects of incorporated ^{90}Sr, and comparison is made with ^{137}Cs in this connection. (UK)

28478 ^{137}Cs AND ^{131}I IN FINNISH MILK FROM SEPT. 1962 TO AUG. 1963. Moisio, Tauno; Miettinen, Jorma K. (Biochemical Inst., Helsinki). Suomen Kem., B, 36: 175-6(1963).

Periodic measurements of ^{137}Cs and ^{131}I content in milk were made on samples taken from the largest tanks (5000 to 15,000 l) of three central dairies in Helsinki, Joensuu, and Rovaniemi. The samples represented one day's milk from 50 to several hundred farms within ~100 km of each dairy. The amounts of ^{137}Cs and ^{131}I in the fresh milk were determined by γ spectrometry. The results obtained are presented in tabular form according to month and area. The maximal ^{131}I content in milk was observed in Helsinki on Sept. 21, 1962; in the two other regions it occurred earlier; the cattle had been taken indoors and fed on summer collected hay. The ^{137}Cs content of milk in northern and eastern Finland was about twice that in Helsinki and western Finland. In Joensuu and Rovaniemi the peak values for fodder grown in the summer of 1962 were obtained at the beginning of March, 1963. The cause of this maximum is not yet known. The values for ^{137}Cs obtained in July and August, 1963, well exceeded those of the previous autumn. Milk samples collected in Aug. and Sept., 1959, from seven experimental farms in southern and middle Finland contained only 16 pCi/l of ^{137}Cs as an average. The average in Helsinki in Sept., 1962, 110 pCi/l, was 7 times higher; that in Aug., 1963, 10 times higher. (BBB)

28479 ANALYSIS AND DETERMINATION OF VARIABLES FOR OPTIMUM DOSE DISTRIBUTION IN MOVING FIELD THERAPY. Perez-Tamayo, R. (Ellis Fischel State Cancer Hospital, Columbia, Mo). Nat. Cancer Inst. Monogr., No. 24, 45-64(1967).

The process used to obtain the optimum combination of variables to produce the required useful treatment area in moving beam therapy was demonstrated with two methods. For a tumor area of known size, shape, and position, it is possible to determine the specific values of the basic variables required to produce the optimum dose distribution with a useful treatment area that will enclose the lesion adequately. In practice, more than one combination of variables will result in the same area, but the optimum combination selected should have the smallest field size and lowest angle of rotation possible to produce the appropriate treatment area with a high axis to maximum dose ratio, and low integral dose. The total dose that must be given to deliver 100 R at the maximum should be low, and the surface dose to the body cross section should be the least possible. The optimum selected combination of variables is the specific combination of field size, angle of rotation, axis of rotation, and doses that produces the best possible balance between these variables and their conflicting effects. Rotation spreads and lowers the percentage of the maximum dose over the circumference, increasing the required total given dose for the same maximum dose, increasing the integral dose, and improving the ratio of axis to maximum dose at the useful treatment area. (BBB)

28480 RADIOACTIVE CESIUM IN THE BIOSPHERE AND IN MAN. Duric, D.; Kilibarda, M.; Panov, D. (Zavod za Medicinu Rada, Belgrade). Higijena, 17: 66-75(1965). (In Serbian).

The distribution and the hazards of radiocesium in the human environment are reviewed (68 references). Origin of ^{137}Cs as a fission product in nuclear explosions is considered, and its transfer via food chains to animals and man is traced. Extensive data are provided on ^{137}Cs levels in water, soil, and plant and animal tissues in various parts of the world. Metabolic pathways of ^{137}Cs, principally as a constituent of muscle with physiologic properties analogous to those of potassium, are surveyed and used as a basis for explaining its deposition in animals. Although it is not retained as tenaciously as radiostrontium, its long half life makes it one

of the more serious fallout contaminants of the biosphere. The hazards of ^{134}Cs, were considered to be less than those of ^{137}Cs. Various methods and materials that may be used to accelerate the elimination of radiocesium from the body are also reviewed. (BBB)

28481 PROCEEDINGS OF THE II. SYMPOSIUM ON HEALTH PHYSICS, PECS, HUNGARY, SEPTEMBER 26–30, 1966. VOL. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966. 140p. (CONF-660948-(Vol.2)).

Separate abstracts were prepared on 25 papers presented at this symposium. (C.H.)

For abstracts of individual papers see: 28244, 28364, 28482–28503, and 28631.

28482 DIAGNOSTIC FILM DOSIMETER IN THE STUDY OF RADIATION EXPOSURE TO THE POPULATION RESULTING FROM X-RAY FLUOROSCOPY. Bojtor, I.; Bogdany, B.; Koczkas, J. (Frederic Joliot-Curie National Research Inst., Budapest). pp 1-4 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

A diagnostic film dosimeter gave satisfactory information on the radiation exposure and scrotum dose of about 2700 patients subjected to chest fluoroscopy. The survey data resulted not only in numerical dosimetric values but gave valuable information also about dose-distribution and the methodology of fluoroscopy. (auth)

28483 DIAGNOSTIC DOSIMETRY FOR MEDICAL RADIATION BURDEN. Gursky, S. (Karl-Marx Univ., Leipzig). pp 5-9 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

The significance and purpose of dosimetry during diagnostic radiography are reviewed. The effects of duration of fluoroscopy, the gonad dose, the incident and depth doses, the size of the dose area, and the incident energy on the radiation dose are illustrated by results of phantom measurements. The effects of the incident area dose are illustrated by dosimetric measurements made during 760 fluoroscopical examinations of the stomach and colon. The effects of incident area doses on the gonad dose was measured during 100 examinations of the stomach. (C.H.)

28484 RADIOLOGIC EXPOSURE OF THE POPULATION OF A GREAT FACTORY. Bugyi, Balazs (Ganz-Mavag Policlinic, Budapest). pp 11-15 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

An investigation was made from 1959 till 1965 of the radiation exposure from medical uses of the employees of a representative factory of Hungary. The changes of the radiation exposure and the maximal individual dose of this specific working population and its causes are discussed. (auth)

28485 FINGER-DOSE MEASUREMENTS IN THE GAMMA-RAY TREATMENT OF UTERINE CARCINOMA BY THERMOLUMINESCENT DOSIMETER. Felszerfalvi, J. (Kossuth Lajos Univ., Debrecen, Hungary); Berta, I.; Osvay, M.; Goergey, M. pp 17-20 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

The dosimeter used to monitor exposures of persons handling ionizing radiation sources is the pocket condenser ionization chamber. This dosimeter is unusable for measuring hand dose. Micro LiF thermoluminescent dosimeters were used for this purpose. The finger dose measured on the hand of a physician who inserted ^{60}Co tubes for interstitial therapy was 0.8 to 0.9 rem per week and on the hand of a nurse was 2.18 rems per week. The results proved the importance of finger-dose measurements. (auth)

28486 EXPOSURE EVALUATION OF PERSONNEL DEALING WITH RADIUM APPLICATIONS. Musialowicz, T. (Central Lab. for Radiological Protection, Warsaw); Wysopolski, J.; Dworakowski, M.; Lobodziec, W. pp 21-5 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

The results are given of measurements of radiation doses received by persons engaged in the insertion of medical radium applicators. A special simple film-badge was used. Doses were measured simultaneously on head, chest, ring fingers, and gonads of physicians while inserting and taking out intravaginal cork cylinders and rubber tubes and changing dressing; and for nurses while preparing radium applicators; unloading after use, and while assisting in inserting and taking out applicators. (auth)

28487 PROBLEMS IN SUBSTITUTING RADIUM BY ARTIFICIAL RADIONUCLIDES IN MEDICINE AND INDUSTRY. Koenig, W.; Ott, R.; Rietdorf, M. (Radiation Protection Center, Berlin). pp 27-30 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

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of the more serious fallout contaminants of the biosphere. The hazards of ^{134}Cs, were considered to be less than those of ^{137}Cs. Various methods and materials that may be used to accelerate the elimination of radiocesium from the body are also reviewed. (BBB)

28481 PROCEEDINGS OF THE II. SYMPOSIUM ON HEALTH PHYSICS, PECS, HUNGARY, SEPTEMBER 26–30, 1966. VOL. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966. 140p. (CONF-660948-(Vol.2)).

Separate abstracts were prepared on 25 papers presented at this symposium. (C.H.)

For abstracts of individual papers see: 28244, 28364, 28482–28503, and 28631.

28482 DIAGNOSTIC FILM DOSIMETER IN THE STUDY OF RADIATION EXPOSURE TO THE POPULATION RESULTING FROM X-RAY FLUOROSCOPY. Bojtor, I.; Bogdany, B.; Koczkas, J. (Frederic Joliot-Curie National Research Inst., Budapest). pp 1-4 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

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A diagnostic film dosimeter gave satisfactory information on the radiation exposure and scrotum dose of about 2700 patients subjected to chest fluoroscopy. The survey data resulted not only in numerical dosimetric values but gave valuable information also about dose-distribution and the methodology of fluoroscopy. (auth)

28483 DIAGNOSTIC DOSIMETRY FOR MEDICAL RADIATION BURDEN. Gursky, S. (Karl-Marx Univ., Leipzig). pp 5-9 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

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The significance and purpose of dosimetry during diagnostic radiography are reviewed. The effects of duration of fluoroscopy, the gonad dose, the incident and depth doses, the size of the dose area, and the incident energy on the radiation dose are illustrated by results of phantom measurements. The effects of the incident area dose are illustrated by dosimetric measurements made during 760 fluoroscopical examinations of the stomach and colon. The effects of incident area doses on the gonad dose was measured during 100 examinations of the stomach. (C.H.)

28484 RADIOLOGIC EXPOSURE OF THE POPULATION OF A GREAT FACTORY. Bugyi, Balazs (Ganz-Mavag Policlinic, Budapest). pp 11-15 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

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An investigation was made from 1959 till 1965 of the radiation exposure from medical uses of the employees of a representative factory of Hungary. The changes of the radiation exposure and the maximal individual dose of this specific working population and its causes are discussed. (auth)

28485 FINGER-DOSE MEASUREMENTS IN THE GAMMA-RAY TREATMENT OF UTERINE CARCINOMA BY THERMOLUMINESCENT DOSIMETER. Felszerfalvi, J. (Kossuth Lajos Univ., Debrecen, Hungary); Berta, I.; Osvay, M.; Goergey, M. pp 17-20 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

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The dosimeter used to monitor exposures of persons handling ionizing radiation sources is the pocket condenser ionization chamber. This dosimeter is unusable for measuring hand dose. Micro LiF thermoluminescent dosimeters were used for this purpose. The finger dose measured on the hand of a physician who inserted ^{60}Co tubes for interstitial therapy was 0.8 to 0.9 rem per week and on the hand of a nurse was 2.18 rems per week. The results proved the importance of finger-dose measurements. (auth)

28486 EXPOSURE EVALUATION OF PERSONNEL DEALING WITH RADIUM APPLICATIONS. Musialowicz, T. (Central Lab. for Radiological Protection, Warsaw); Wysopolski, J.; Dworakowski, M.; Lobodziec, W. pp 21-5 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26–30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

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28503 THE RADIOACTIVITY OF SOME SURFACE WATERS OF HUNGARY. Gaal-Dippold, Anne (State Inst. of Hygiene, Budapest). pp 131-5 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26-30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

During the radiological check of the surface waters in Hungary, it was established that, generally speaking, the rivers entering the country did not carry any objectionable amount of radioactive material during the 1963 to 1965 period, except for a single stream. Some increase in the activity of the surface waters was observed during 1963 to 1964, however the activity of most surface waters showed marked decrease in 1965. According to the investigations accomplished so far the waste waters of the few country towns in which open isotopic preparations are used do not endanger surface waters. (auth)

28504 UMGANG MIT RADIOAKTIVEN STOFFEN. (Association With Radioactive Materials). Mueller, Rolf-Heinz. Munich, Carl Hanser Verlag, 1966. 262p.

Agreements made according to the First Radiation Protection Ordinance are summarized. The physical bases of radiation are reviewed, and the effects of ionizing radiation on human beings are discussed. The use of radioactive materials in industry, research, and medicine is considered. Regulations on the transportation of radioactive materials are outlined. (J.S.R.)

28505 UMWELTRADIOAKTIVITAET UND STRAHLENBELASTUNG. Bericht IV/66. (Environmental Radioactivity and Radiation Burden. Fourth Quarterly Report, 66). Bad Godesberg, Ger., Bundesminister fuer Wissenschaftliche Forschung, 1967. 197p. DM 11.-.

The content of the radioactive materials in air, water, soil, and food materials and the radiation burden of the population in the German Federal Republic measured during the fourth quarter of 1966 are reported in graphic and tabular form. (J.S.R.)

28506 UMWELTRADIOAKTIVITAET UND STRAHLENBELASTUNG. Bericht III/66. (Environmental Radioactivity and Radiation Burden. Third Quarterly Report, 66). Bad Godesberg, Ger., Bundesminister fuer Wissenschaftliche Forschung, 1966. 218p. DM 12.-.

The content of the radioactive materials in air, water, soil, and food materials and the radiation burden of the population in the German Federal Republic measured during the third quarter of 1966 are reported in graphic and tabular form. (J.S.R.)

28507 ZASHCHITA OT IONIZIRUYUSHCHIKH IZLUCHENII. (Protection Against Ionizing Radiation). Kimel', L. R.; Mashkovich, V. P. Moscow, Atomizdat, 1966. 312p.

Basic materials on the radiation of the most widely used radioactive isotopes and fission product mixtures are compiled and systematized. The maximum permissible levels; protection from γ, neutron, α, and β radiation; effects of heterogeneity in shields in radiation transmission are considered. The principal conversions for calculation of irradiation fields are examined. Information is given on the albedo of γ radiation. The transmission of radiation through heterogeneous shields is examined. (J.S.R.)

28508 RADIOLOGICAL PHYSICS. SECOND EDITION. Young, M. E. J. Springfield, Ill., Charles C Thomas Publisher, 1967. 611p. $16.50.

After a brief summary on the fundamental concepts of atomic and nuclear physics, electromagnetic radiation, and vacuum tube and semiconductor devices various aspects of radiological physics are discussed in detail. These are the production of x rays, radioactivity, interaction of gamma and x rays with matter, detection of ionizing radiations, physical principles of diagnostic radiography, chemical and biological effects of ionizing radiations, diagnostic and therapeutic use of ionizing radiations and health hazards and radiological protection. (B.G.D.)

Medicine

Refer also to abstracts 28449, 28468, 28485, 28488, 28504, 28508, 28590, 28600, 28697, 28701, 29695, and 29696.

28509 (ACRH-1000-6) RADIATION THERAPY OF THE LARYNGEAL AND TRACHEAL TUMORS WITH HIGH ENERGY ELECTRONS USING PENCIL BEAM SCANNING. Griem, Melvin L.; Skaggs, Lester S.; Lanzl, Lawrence H. (Chicago Univ., Ill. Dept. of Radiology. Argonne Cancer Research Hospital, Chicago, Ill.). Sept. 1966. Contract AT(11-1)-69. 17p. (CONF-660946-1). Dep. CFSTI.

From Symposium on Megavolt and Very Fast Electron Therapy, Madrid, Spain.

Electron beam therapy for advanced tumors of the larynx with lymph node metastases offers a unique and simple approach to treatment. Dosimetry for such treatment and for treatment of tumors of the trachea is presented. Results of treatment are encouraging with adequate control of advanced lesions of the larynx and with evidence to suggest control of lymph node metastases in a number of cases. A brief description of the pencil beam scanning electron linear accelerator at the Argonne Cancer Research Hospital is given. (auth)

28510 (DASA-1852) THE EFFECTS OF AMBIENT PRESSURE ON TOLERANCE OF MAMMALS TO AIR BLAST. Technical Progress Report. Damon, Edward G.; Gaylord, Charles S.; Hicks, William; Yelverton, John T.; Richmond, Donald R.; White, Clayton S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1966. Contract DA-49-146-XZ-372. 37p. Dep. CFSTI.

Seventy-six dogs, 43 goats, 211 rats, and 255 guinea pigs were exposed to reflected shock pressures at ambient pressures ranging from 5 to 42 psia in air-driven shock tubes. Animal tolerance, expressed as LD_{50}-one-hour overpressures rose progressively as the ambient pressure was increased. By analysis of the results of this study, combined with those from previous shock-tube investigations, a general equation for the regression of LD_{50} pressure on ambient pressure for mammals was derived. From this equation and previous estimates of the LD_{50} pressure for man's tolerance to overpressures of 400-msec duration at an ambient pressure of 12 psia, an equation relating LD_{50} pressure to ambient pressure was developed for the 70-kg mammal. (auth)

28511 (DASA-1853) DASA-AEC-LOVELACE FOUNDATION BLAST-SIMULATION FACILITY. Technical Progress Report. Richmond, Donald R.; Gaylord, Charles S.; Damon, Edward G.; Taborelli, R. V. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1966. Contract DA-49-146-XZ-372. 49p. Dep. CFSTI.

The DASA-AEC-Lovelace Foundation Blast-Simulation Facility for the biomedical investigation of the effects of Blast and Shock is described in detail. Photographs, descriptions, and specifications of four air-driven shock tubes, ranging from 12 to 72 in. in diameter, and a concrete-pad, high-explosive test site are given. The instrumentation system and shock-tube and gauge-calibration procedures are included. Test parameters for each shock tube are briefly summarized and supported by typical pressure-time patterns and calibration curves. (auth)

28512 (DASA-1854) AIR-BLAST STUDIES WITH EIGHT SPECIES OF MAMMALS. Technical Progress Report. Richmond, Donald R.; Damon, Edward G.; Bowen, I. Gerald; Fletcher, E. Royce; White, Clayton S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1966. Contract DA-49-146-XZ-372. 52p. Dep. CFSTI.

A series of three experiments were carried out. A total of 204 dogs and 115 goats were exposed to shock-tube and high-explosive-produced reflected shock waves ranging in duration from 400 to 1.5 msec. LD_{50} values, calculated by probit analysis, showed similar patterns for both species, increasing at the shorter durations by a factor of 4 or 5 above those for long durations. Sixty dogs were exposed in a shock tube to sharp-rising overpressures of near 400-msec duration at six-dose levels ranging from 9.2 to 35.8 psi. The degree of lung injury was graded and threshold for petechial hemorrhage determined. Dose-response curves were compiled using data for 200 mice, 110 hamsters, 150 rats, 120 guinea pigs, 48 cats, and 40 rabbits exposed to long-duration reflected pressures in a shock tube. The tolerances (LD_{50}) for all six species are compared. Pathological observations for all species and lung-weight data for cats and hamsters are included. Criteria for relating biological response to the various parameters of the blast wave are discussed. (auth)

28513 (DASA-1855) THE TOLERANCE OF CATTLE TO "LONG"-DURATION REFLECTED PRESSURES IN A SHOCK TUBE. Technical Progress Report. Damon, Edward G.; Gaylord, Charles S.; Yelverton, John T.; Richmond, Donald R. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1966. Contract DA-49-146-XZ-372. 37p. Dep. CFSTI.

Twenty-seven steers, mounted side-on against the endplate of an air-driven shock tube, were exposed to sharp-rising reflected pressures of 184-msec duration. Pressure-time measurements were made with piezoelectric pressure transducers. Autopsies

were performed on all animals and the nature of their blast injuries determined. The LD_{50} reflected pressure, obtained by probit analysis, was 43.1 psi for steers having a mean body weight of 180 kg. The results are compared with tolerance values obtained in previous investigations involving exposure of eight species of smaller animals to overpressures of 400 to a msec duration. Twenty-four hour, time-lethality data for steers are compared with those of five species of smaller animals. The potential use of blast-injured domestic animals, as a source of food, is briefly discussed. (auth)

28514 (DASA-1856) THE SCOPE OF BLAST AND SHOCK BIOLOGY AND PROBLEM AREAS IN RELATING PHYSICAL AND BIOLOGICAL PARAMETERS. Technical Progress Report. White, Clayton S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1966. Contract DA-49-146-XZ-372. 28p. Dep. CFSTI.

The nature of hazards from air blast is discussed noting those due directly to variations in pressure and indirectly to the impact of penetrating and nonpenetrating, blast-energized missiles and the consequences of whole body displacement due to blast-induced winds or ground shock. The need for developing biomedical criteria based upon critical and measurable biological responses following exposure to significant and monitorable physical parameters is considered in relation to hazards assessment. Also the multifaceted problem of tying up such information with blast-induced variations in the environment that occur free-field and under various conditions of exposure was noted and emphasized. (auth)

28515 (DASA-1857) BIOPHYSICAL MECHANISMS AND SCALING PROCEDURES APPLICABLE IN ASSESSING RESPONSES OF THE THORAX ENERGIZED BY AIR-BLAST OVERPRESSURES OR BY NON-PENETRATING MISSILES. Technical Progress Report. Bowen, I. G.; Fletcher, E. R.; Richmond, D. R.; Hirsch, F. G.; White, C. S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1966. Contract DA-49-146-XZ-372. 46p. Dep. CFSTI.

A mathematical model was described that was devised to study the dynamic response of the thorax of mammals to rapid changes in environmental pressure and to non-penetrating missiles impacting the rib cage near the mid-lateral point of the right or left thorax. Scaling procedures for similar animals were described relating, for a given degree of damage, the body mass of the animal to various parameters describing the exposure dose. Internal pressures computed with the model for a dog exposed at the end plate of a shock-tube were compared to those measured with a pressure transducer inserted in the esophagus down to the level of the heart. Computed time-displacement histories of missiles following impact with the right side of the thorax were compared to those obtained experimentally by means of high-speed motion picture photography. High internal pressures predicted with the model for non-penetrating impact were compared to those obtained experimentally and theoretically for exposure to air blast. Experimental data were presented arbitrarily assessing lung damage in animals struck by non-penetrating missiles (constant impact area) as a function of missile mass and impact velocity. These data were compared for several missile mass-velocity combinations with those computed using the mathematical model. Similarities in the dynamic responses of the thorax to air blast and to non-penetrating missiles were discussed. (auth)

28516 (DASA-1858) EFFECTS OF OVERPRESSURE ON THE EAR. A Review. Technical Progress Report. Hirsch, Frederic G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1966. Contract DA-49-146-XZ-372. 35p. Dep. CFSTI.

Information regarding blast effects on the ear was reviewed in an attempt to gather quantitative information available for animals and man for help in the establishment of relationships between various levels of overpressure and the incidence of eardrum failure, the degree of damage to the middle and inner ear and other identifiable sequelae referable to cochlear or vestibular functions. (auth)

28517 (LA-DC-8433) CHELATING AGENTS IN PLUTONIUM DEPOSITION: A MINORITY VIEW. Schulte, Harry F.; Whipple, Harry O. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 9p. (CONF-670521-2). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

The factors against routine use of chelating agents in plutonium exposure are as follows: The drugs are of a significant degree of toxicity, the administration of these agents makes early evaluation of the seriousness of the incident difficult or impossible, the amounts of radioactive element mobilized in most clinical situations are not enough to be of real value, the effects on trace mineral metabolism and long term effects are not well known, and the only drug currently recommended for this purpose cannot legally be used on humans in the United States. (auth)

28518 (ORINS-52) SOURCE ARRANGEMENT FOR A LOW-EXPOSURE-RATE TOTAL-BODY IRRADIATION FACILITY FOR MAN. Dalton, Patricia; Cloutier, Roger (Oak Ridge Associated Universities, Tenn.). May 1967. Contract AT(40-1)-Gen-33. 211p. Dep. CFSTI.

A facility for therapeutic, total-body irradiation of patients at exposure rates of 0.5, 1, and 5 R/hr is under construction at the ORINS Medical Division. Preliminary to architectural and engineering designs, a study was made of possible arrangements of sources to provide the facility's radiation field. This field must be large and uniform enough to permit patients to move about during treatment periods of up to two weeks. The treatment room required is at least 6 ft high and 14 ft square with a variation in the exposure rate of 10% or less. Exposure rates and isodose lines have been calculated for 15 configurations of 1, 2, 4, 6, 8, and 10 sources assuming that the exposure rate at a point is proportional to the inverse square of the distance to the source. Computer data describing the radiation fields from these source arrangements are included. The facility consists of a treatment room 6 ft high and 16 × 16 ft in area centered inside a building 18 × 30 × 30 ft. The source arrangement selected comprises eight ^{60}Co sources (26 curies each) located near the corners of the outer building and two smaller sources (4 curies each) centered near the floor and ceiling. (auth)

28519 (UCRL-17441) A REVIEW OF THE PHYSICAL CHARACTERISTICS OF PION BEAMS. Raju, Mudundi R.; Richman, Chaim; Curtis, Stanley B. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 17, 1967. Contract W-7405-eng-48. 27p. (CONF-670305-4). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Experimental bases for the use of negative pions in radiotherapy are reviewed. Following pion capture by tissues, the pion cascades down the atomic levels to the ground state of the atom in a time that is short compared with its lifetime. From the ground state it is captured by the constituent nucleus, which explodes into a star consisting of short-range heavily ionizing fragments. The relative frequency with which different elements capture pions is closely proportional to their relative abundance by mass. Energy partition for negative pion capture in water is calculated for a pion beam containing muon and electron contaminants. Negative pions are produced in the reaction of the proton beam with the neutrons in the Be nucleus. Intensity of the negative pion beam at the 184-inch synchrocyclotron at Berkeley is 5 rads/hr for a beam size of ≈7 cm by 7 cm. The beam has a contamination of 25% electrons and 10% muons, and the beam intensity is two orders of magnitude lower than that needed for therapeutic application. It is concluded that negative pion beams may be applicable in radiotherapy. (H.G.D.)

28520 STUDIES ON MECHANISM OF RESTORATION OF IMPAIRED IMMUNOLOGICAL CAPACITY BY LYMPHOCYTES. 1. EFFECT OF THORACIC DUCT LYMPHOCYTES ON ANTIBODY PRODUCTION IN IRRADIATED RABBITS. Nagatani, Yasuo (Kyoto Univ.). Nippon Ketsueki Gakkai Zasshi, 29: No. 1, 49-59 (Feb. 1966). (In Japanese).

The present study was carried out to show that lymphocytes play an important role in antibody production. Thoracic duct lymphocytes were collected from donor rabbits which had been injected with typhoid bacilli directly into their mesenteric lymph nodes 4 days previously. The lymphocytes were then subjected to alternating freezing and thawing three times. The results indicate that sensitized thoracic duct lymphocytes have the ability to accelerate and increase specifically the antibody production in rabbits 4 days after irradiation and that the supernatant from these lymphocytes participates in this activity. It was also found that antibody production is increased and accelerated even after contact in vivo or in vitro with sensitized thoracic duct lymphocytes. (NSA of Japan)

28521 SUPPLEMENTAL TREATMENT AND OBSERVATION OF PROGRESS DURING RADIOTHERAPY AND CYTOSTATIC TREATMENT. Becker, J.; Kaercher, K. H.; Kleibel, F. (Univ., Heidelberg). Radiologe, 6: 159-75(Apr. 1966). (In German).

Although side-effects consisting of generalized or localized irradiation reactions are infrequently observed if proper precautions are used after supervoltage therapy and chemotherapy of malignant tumors, increased focal doses may produce unavoidable reactions in the skin, mucosa, and parenchymatous organs. In addition, individuals vary in their reactions to irradiation, depending on the single dose, total dose, arrangement of the fields, and the space dose. Local as well as generalized reactions can be treated and influenced by a knowledge of the various causal factors. Noradrenalin has proven useful in treatment of the orthostatic circulatory dysfunctions produced during radiotherapy. Supplementary

treatment with adrenal hormones has been found to fully correct for low hormone values observed in patients in poor physical condition during irradiation therapy. Changes in serum protein and serum glycoproteide distribution observed during and after irradiation have been corrected by administration of anabolic steroids. Similar alterations in carbohydrate and fat metabolism also are normalized by anabolic hormones by suppression of hyperglycemia and reduction of triglycerides, cholesterol, and phospholipides in serum. Retention of N and P, too, are favored by administration of anabolic hormones, promoting hemoglobin synthesis and bone marrow regeneration. Immune processes, γ-globulin, and vitamins also have a role in radioprotection. The role of various enzymes in reactions to irradiation is discussed at length. References cited, 173. (BBB)

28522 APPLICATION OF LYMPHOGRAPHY IN RADIOTHERAPY. Holsti, L. R.; Wiljasalo, M. (Univ., Helsinki). Ann. Med. Inter. Fenn., 55: 81-6(1966).

Effects of megavoltage radiation on the lymphatic system were studied in 124 patients with retroperitoneal tumors. Radiation therapy was administered by a 35-MeV betatron unit using both high energy photons (33 MeV) and electrons (20 to 34 MeV). In some cases the treatment was given with a radiocobalt unit. The weekly tumor dose was 1000 rad, the total tumor dose being in lymphomas 3000 rad and in carcinomas 4000 to 5000 rad. Three different fields were used in the treatment of lymphomas, viz., 1 aortic and 2 parailiac. In Hodgkin's disease the nodes were enlarged, and were as a rule perceptibly diminished after 2300 rad, or even less, by 33-MeV x-ray treatment. In the chronic form of this disease, in which amyloid had accumulated in the nodes, irradiation did not effect it. As regards other lymphomas, such as reticulum-cell sarcoma, lymphosarcoma, and lymphatic leukemia, the primarily large nodes diminished greatly even with 1500 rad in some cases. With metastases from carcinomas the nodes were distinctly enlarged in about 24% of the cases and became smaller after 3000 rad. Lymphomas were sensitive to radiation and the effect of radiation on superficial nodes was marked. Metastases of head and squamous cell carcinomas of the neck were considerably more resistant to radiation and reflected the radiation response of the primary tumors. (BBB)

28523 COMPARATIVE THERAPEUTIC EFFICACY OF HIGH-LET VERSUS LOW-LET RADIATIONS. Bond, V. P.; Robinson, C. V.; Fairchild, R.; Tisljar-Lentulis, G. (Brookhaven National Lab., Upton, N. Y.). Nat. Cancer Inst. Monogr., No. 24, 23-44(1967).

In this consideration of the possible efficacy of high-LET radiations in radiotherapy, attention was particularly devoted to evaluation of the degree to which high-LET radiations may aid in overcoming the problem of relatively radioresistant tumor cells in hypoxic foci within neoplasms. The following subjects are covered: neutron-capture therapy, accelerator beams (particularly protons and negative π mesons), fast neutrons, and the influence of LET-associated changes in cell-survival curves on possible efficacy of high-LET radiations. Discussed are the advantages and difficulties of the various approaches. The use of high-LET radiations can be advantageous or disadvantageous. It can be advantageous only if the curve for normal cells with low-LET radiations is below that for tumor cells. The advantageous situation can lead to cure, however, only if a favorable differential repair rate exists. It is possible, in principle, that high-LET radiations may provide effective modalities for therapy, and in particular, that they may aid in overcoming the problem of relative protection of tumor cells located in hypoxic areas within neoplasms. In all approaches, it is necessary to consider carefully the concomitant changes in shape of dose-cell survival curves that accompany the change from low- to high-LET radiations. While the proposals examined have interesting features, each requires considerably more work before it can be shown to be a useful adjunct in radiotherapy. (BBB)

28524 CARCINOMA OF THE THYROID AFTER X-RAY THERAPY TO THE NECK: REPORT OF A PATIENT TREATED AFTER THIRTY-TWO YEARS. Rath, Hans; Bierbower, R. L.; Tamisea, Jerry X. Amer. J. Surg., 113: 390-3(Mar. 1967).

A case is reported of papillary adenocarcinoma of the thyroid in an adult who had received irradiation to the neck in childhood. At 5 yr of age, he had received x-ray therapy to both sides of the neck for enlarged tonsils and adenoids. One year later excision of the tonsils and adenoids was performed. At 12 yr of age, 7 yr after the x-ray therapy, a painless mass developed on the right side of the neck both laterally and superiorly. This gradually enlarged over the ensuing years, but the patient remained in excellent general health. In the 32nd yr after appearance of the tumor, right radical neck gland dissection and right thyroid lobectomy were performed. The operation disclosed that the most medially placed lobule arose from the lateral aspect of the right lobe of the thyroid. The literature relating to the radiation induction of thyroid tumors is reviewed, showing that an average of 8.7 yr elapsed between the appearance of the thyroid carcinoma and the previous irradiation. Most thyroid carcinomas associated with prior irradiation have been papillary carcinomas, as was this one. The average age of the patient on appearance of the tumor is 9.6 yr with a range of 4 to 14.6 yr. In this case the patient was 12 yr old when the mass in the neck appeared. (BBB)

28525 EFFECTS OF SMALL DOSES OF RADIATION. Dullum, Dell F. (California State Dept. Health, Sacramento). pp 105-35 of Radiodermatitis. Epstein, Ervin (ed.). Springfield, Ill., C. C Thomas, 1962.

The following aspects of this topic are considered: general biological effects of radiation; the acute radiation syndrome; genetic effects; somatic effects; modification and therapy of radiation injury; exposure from natural background, medical uses, and occupational sources; fallout hazards; and regulatory activities. Medical uses of radiation furnish the largest proportion of the dose from man-made radiation to the whole body, including the gonads and bone marrow, in the United States. This dose is equal to or greater than that from all natural radiation sources. The hazards associated with medical uses, primarily as concerns the genetically significant gonadal dose, are discussed. This is contributed almost entirely by diagnostic procedures, and principally by those procedures in which the unprotected gonads are included in the area of direct primary radiation. The average gonadal and marrow dose in various diagnostic procedures is shown in a table. Estimates of the whole population average gonadal dose from diagnostic procedures are also provided. Some means by which the total radiation dose to patients may be decreased, particularly by eliminating unnecessary irradiation, are described. The average medical or dental patient receives more irradiation than is actually necessary in any given x-ray diagnostic procedure. It is pointed out that the "saving" in radiation exposure which can be effected in medical uses can more than offset the additional radiation incident to the planned expansion of nuclear power and the other peacetime uses of radiation in industry and commerce. (BBB)

28526 CLEARANCE CURVES OF ^{85}Kr OR ^{133}Xe CONSIDERED AS A SUM OF MONO-EXPONENTIAL OUTWASH FUNCTIONS: DESCRIPTION OF A COMPUTER PROGRAM FOR THE SIMPLE CASE OF ONLY TWO COMPARTMENTS. Sveindottir, E. (Univ. of Copenhagen). Acta Neurol. Scand., 69-71(1965).

The concept of a diffusion equilibrium between tissue and venous capillary blood in each individual tissue compartment predicts that the clearance curve, $C(t) = c(t)/c(0)$ of ^{85}Kr or ^{133}Xe, over the brain is a weighted average (a summation) of a number of exponential curves. For a slug injection of the isotopes intra-arterially the individual weighting factors are the fractional weights multiplied by the blood flow and normalized by dividing by the sum of these products. As the brain may be considered to be composed of infinitely many compartments, a continuous distribution of the weights as a function of the clearance constant may be introduced. The problem of analyzing the ^{85}Kr and ^{133}Xe clearance curves into compartments was reduced to that of determining a transform which was derived. Two different approaches were used. First, it is possible to avoid assumptions as to the possible distribution of the compartments, but due to the nature of the problem (representation by exponential functions, i.e., an extremely non-orthogonal function system) a very high accuracy was necessary to obtain an acceptable degree of resolution. The second consisted of representing C(t) by a simple function whose inverse transform is known. A computer program written in ALGOL giving a least square best fit by successive approximations of 2 exponentials to C(t) was developed for the Danish computer GIER. The results are similar to those obtained by conventional graphical analysis of a semilogarithmic plot. (BBB)

28527 THE RADIATION LESION IN PHYSICIANS: OCCUPATIONAL DISEASE. Lenarduzzi, G. (Univ., Padua, Italy). Minerva Med., 56: 1441-2(May 5, 1965). (In Italian).

The genetic and somatic effects of ionizing radiations are discussed, particularly in relation to chronic exposure in physicians who use x rays and other forms of radiation in medical practice. The usual manifestation in radiologists, who formerly received excessive exposure, is chronic radiodermatitis, and occasionally hematologic disorders have been noted. Possible genetic implications of such exposure in radiologists are considered. Means which have now been taken to prevent excessive occupational exposure in the medical profession are mentioned relative to the decreasing occurrence of radiation-connected injuries, which are now infrequently seen in physicians. Also discussed is legislation in Italy, which was initiated 40 yr ago, to prevent misuse of radiations in the medical profession. Recent studies indicate that most instances of misuse of radiation in medical fields are not attributable to professional radiologists, but to those, such as surgeons, who use radiation only incidentally. Present legislation in Italy ensures mandatory control of all radiation equipment from the point of view of safe operation. (BBB)

28528 TREATMENT OF LUNG CANCER. Med. Times, 94: 211a(Aug. 1966).

Lung cancers, judged by conventional standards to be inoperable, can be made operable by irradiating them with supervoltage x rays or ^{60}Co γ rays over periods of several weeks, as shown by results in 200 lung cancer patients. Such patients treated with radiation followed by surgery were shown to have the same survival rate as patients with operable cancers. About 23% in each group have survived for one or more yr. Further significant improvements in cancer therapy may be expected through a proper combination of irradiation and surgery. This new approach differs in several respects from earlier methods of preoperative radiation therapy for cancer. These have consisted of nonlethal exposures of cancer cells to radiation over a period of 1 to 5 days, completed 1 to 7 days before surgery. Their purpose was to reduce cancer cell vitality so as to minimize the spread of cancer cells in the bloodstream during the surgical procedure. The new approach involves doses strong enough to kill all cancer cells. The patients are irradiated daily over 4 to 8 weeks, not only in the area where cancer can be detected by diagnostic procedures, but throughout the region where doctors believe microscopic traces of cancer exist. Surgery is performed 5 to 8 weeks after irradiation. In the usual so-called inoperable cancer, the disease had extended to lymph nodes between the lungs or had become attached to vital structures such as the blood vessels leading to and from the heart. Several weeks after irradiation the cancer had regressed or disappeared in these areas and the remaining cancer could be removed by taking out all or part of one lung. Complications such as development of abscesses in the irradiated areas and delay in healing after surgery occurred at first with the new procedure, but over the past 3 yr complications have been reduced to 10%. (BBB)

28529 REMOTE RESULTS OF COLLOIDAL RADIOGOLD TREATMENT OF PATIENTS WITH METASTASES OF SKIN MELANOMA. Kozlova, A. V.; Likhovetskaya, L. L. (Inst. of Ministry of Public Health, USSR). Med. Radiol., 12: No. 4, 20-4(Apr. 1967). (In Russian).

Studies were conducted on the use of colloidal radiogold for treatment of 70 patients suffering from metastases of melanoma of the skin and lymph nodes. In some cases there were multiple metastases. In one-third of patients metastases developed in the skin and lymph nodes simultaneously. Between 1954–1963 the method of colloidal radiogold introduction into the tumor was employed. In most cases the local absorbed dose amounted to 100,000 RAD. An analysis of the remote results demonstrated that 16.0 per cent of patients lived for five years and more. (tr-auth)

28530 SUCCESSFUL TREATMENT OF POST-RADIATION URETERAL STRICTURE BY SIMPLE LINEAR INCISION. Alkema, H. D.; Ratliff, R. K. (St. Joseph Mercy Hospital, Ann Arbor, Mich.). J. Urol., 97: 251-3(Feb. 1967).

Development of ureteral stenosis and hydroureter as a result of radiotherapy and its surgical correction are described. The 69-yr-old woman was treated for endometrial carcinoma with intracavitary Ra, 100 mg for 70 hr, amounting to a dose of 7000 mg-hr, with an estimated 5800 R being delivered to the point of reference designated as Point A. She remained clinically well for about 18 months, when abdominal pain developed. Excretory urograms disclosed right hydronephrosis, with an obstruction of the right ureter. The area of obstruction of the ureter corresponded exactly in location to the region in which the intracavitary Ra had been placed, 20 months before. At operation there was no evidence of recurrent neoplasm. The ureter was found to be densely scarred and was encased in scar tissue. A fine longitudinal incision was made in the ureter between the dilated portion and about 2 in inferior over the strictured area down to the mucosa. Care was taken not to cut into the lumen of the ureter. No effort was made to place the ureter back in its proper location but it was covered only with sigmoid and its accompanying fatty epiploic appendages. The ureteral catheter was removed 2 days postoperatively. This patient continued to be well and urograms 1 yr after operation were normal. The literature relating to ureteral radiation injury and its repair are briefly reviewed. (BBB)

28531 THE USE OF IODIDE ^{131}I IN GAMMAENCEPHALOGRAPHY. STUDY OF 300 CASES AND COMPARISON WITH S. A. ^{131}I AND NEOHYDRIN ^{197}Hg. Akerman, M.; Basso, M.; Guiot, G. (Hopital Foch, Suresnes, France). Ann. Radiol., 10: 56-68(1967). (In French).

An assessment of the usefulness of ^{131}I in γ encephalography was made, based on its use in 300 patients, 106 of whom had space-occupying lesions. The results are compared to those obtained using other products, such as ^{131}I serum albumin and Neohydrin labeled with ^{197}Hg. Iodide–^{131}I gives results which are slightly inferior to those obtained using ^{131}I serum albumin but comparable to those obtained using other radioelements in particular ^{99}Tc. It has the advantage of giving extremely rapid results, of delivering little irradiations to the whole body, and of being quickly excreted. This latter factor means that it is particularly well suited to the investigation of children, to whom it can be given orally. It is a conveniently used radioelement, it is cheap, and is easy to obtain and store. (auth)

28532 RADIOISOTOPE INVESTIGATIONS OF THE LIVER IN DISEASES OF THE THYROID GLAND. Slavnov, V. N. Med. Radiol., 12: No. 4, 53-7(Apr. 1967). (In Russian).

The function of polygonal cells was studied with the aid of iodine-131-labelled rose bengal, whereas the functional state of reticuloendothelial cells—with the aid of a colloidal solution of ^{198}Au. Conclusions were drawn on the basis of examination of 210 persons. Functional disturbance of polygonal cells of the liver was noted in patients with thyrotoxicosis, hypothyrosis and myxedema, as well as in persons treated with radioiodine for residual manifestations of thyrotoxicosis or its relapse. In apparently healthy persons treated in the past with radioiodine for thyrotoxicosis there were seen changes towards normalization in the function of the liver, however, there were shifts associated with disturbance of intrahepatic blood circulation. The function of reticuloendothelial cells was deranged in patients protractedly suffering from euthyroid goiter, hypothyreosis and myxedema, as well as in patients with residual manifestations of thyrotoxicosis after radioiodine treatment. (tr-auth)

28533 ASSESSMENT OF BIOCHEMICAL AND ISOTOPE METHODS OF INVESTIGATION IN PATIENTS WHO HAVE SUSTAINED INFECTIOUS HEPATITIS. Startseva, E. K.; Makarenko, S. A. Med. Radiol., 12: No. 4, 58-61(Apr. 1967). (In Russian).

A complex functional investigation of the liver in 88 patients who have sustained infectious hepatitis at different periods after the end of hospitalization was studied. For this purpose some biochemical reactions were staged and parallel functional studies with the aid of radioiodine-labelled bengal rose were made. Data obtained show that the method of isotope indication objectively and precisely reflects the degree of affection of hepatic cells, and is more advantageous than clinical and indirect biochemical investigations. With the aid of this method it was possible to reveal patients manifesting latent forms of chronic infectious hepatitis with a predisposition to transform into cirrhosis. (tr-auth)

28534 RADIOISOTOPE INVESTIGATION OF THE LIVER FUNCTION IN DRUG-INDUCED TOXICO-ALLERGIC REACTIONS IN PATIENTS AFFECTED WITH TUBERCULOSIS. Vil'derman, A. M.; Frenkel, V. Kh.; Reznik, S. E.; Tikhun, M. N. Med. Radiol., 12: No. 4, 62-6(Apr. 1967). (In Russian).

Functional investigations of the liver were carried out with the aid of radioiodine-labelled rose bengal during antibacterial therapy in 50 patients suffering from tuberculosis of the lungs. A system of calculation was used which reflects the degree of activity changes at different time periods and, consequently, not depending upon individual peculiarities of the patient. In toxico-allergic reactions running a course mainly with symptons of affection of the gastrointestinal tract or liver a decrease of indices prevalently of the second period of stain absorption by polygonal cells. In such reactions there occurs a significant reduction of stain excretion by hepatic cells, as well as of the passage of bile into the intestine. An analysis of the data obtained show a picture of cholestasis and a significantly less marked injury of the hepatic parenchyma. (tr-auth)

28535 15-YEAR REMOTE RESULTS OF SHORT-DISTANCE GAMMATHERAPY OF MALIGNANT TUMORS OF THE LARYNX. Astrakhan, B. V. Med. Radiol., 12: No. 4, 24-30(Apr. 1967). (In Russian).

Patients with first-third stage cancer of the larynx were subjected to short-distance gamma radiotherapy on an apparatus with radium-mesothorium or ^{60}Co source, in 6 cm distance of source-skin. The tumor dose during 4 to 7 weeks was increased up to 5,000 to 8,000 RAD. The most favorable results were obtained when the tumor was localized in the median region of the larynx: without relapse and metastases not less than three years 84.4 per cent of patients are alive, not less than fifteen years—64.8 per cent of patients. In tumors located in all three regions of the larynx three-year and fifteen-year positive results were in 45.5 and 25.0 per cent of cases. As a rule, the best effect was attained with a focal dose of 7,000 to 8,000 RAD: without relapse and metastases three-year, five-year and fifteen-year—90.5, 88 and 70.8 per cent of cases. In first-third stage of cancer of the larynx 90.8 per cent of patients recovered, subsequently without relapse and metastases lived not less than three years—75.7 per cent, five years—71.2 per cent, 10 years—64.7 per cent, 15 years—52.5 per cent of cases. The use of additional surgical treatment (mainly laryngectomy) improved the remote positive results. (tr-auth)

28536 THE REMOTE RESULTS OF ROENTGEN THERAPY OF RETROPERITONEAL MALIGNANT TUMORS IN CHILDREN. A REPORT OF TWO CASES. Mints, M. M. Med. Radiol., 12: No. 4, 30-2(Apr. 1967). (In Russian).

An investigation is described on the recovery after massive x radiotherapy (the skin dose of 12,631 and 9,504 R) occurring in two children suffering from inoperable retroperitoneal malignant tumor infiltrating into the right kidney, liver and intestine (follow-up—6.2 and 8.2 years). The tumors, notwithstanding the absence of histological confirmation, were recognized as neuroblastoma by the clinico-roentgenological picture. The latter showed the presence of extensive calcifications in the region of the tumor and by infiltration into adjacent organs. (tr-auth)

28537 EFFECTIVENESS OF COMBINED CHEMICAL AND X RAY THERAPY IN EXPERIMENTS. Zedgenidze, G. A.; Amosov, I. S.; Kaperko, F. F.; Kharlampovich, S. I.; Podsosov, S. P.; Tylechkina, O. D. (Inst. of Medical Radiology, Moscow). Med. Radiol., 12: No. 4, 3-8(Apr. 1967). (In Russian).

An investigation was carried out on rats of the August line with M-1 and UMP-1 transplantable sarcomas. For these strains the effectiveness of combined x-ray therapy and some antineoplastic substances (colchamine and spirosidine) on treatment of tumors. Simultaneous action on experimental transplantable sarcomas by cytostatic antineoplastic substances and ionizing radiation raises the efficacy of treatment, causing no essential changes in the erythropoiesis and leukopoiesis. The combined action of radiation, and chemical factors causes an inhibition in the growth of the tumor and its reverse development at earlier periods. (S.M.H.)

28538 NEUTRONS AGAINST CANCER. Brit. Med. J., 1: 712-13(Mar. 25, 1967).

Use of fast neutrons for the treatment of malignant disease and development of an improved neutron source at the Services Electronics Research Laboratory, Baldock (England) are discussed. The biological basis for neutron therapy lies in the observation that anoxic cells in a tumor, which are relatively resistant to attack by x rays or γ rays, are not protected to the same extent from destruction by neutrons. The practical fulfillment of these possibilities is brought nearer by 2 technical advances now in progress. Firstly, the neutron source developed at Baldock has distinct advantages over equipment previously available. Neutrons are generated in a sealed discharge tube containing deuterium and tritium and energized by a relatively simple high-tension unit. The Baldock tube is sealed, thus avoiding the cost and complexity of vacuum pumps, and gives a high output which remains stable over a long period. Tubes now in production will give a total output of 10^{11} neutrons/sec, which is enough for experimental studies but not for realistic neutron therapy. Design studies are well advanced for a tube with an output of about 3×10^{12} neutrons/sec. Secondly, it is likely that a neutron generator can now be made of adequate output and suitable for the treatment of patients by well-established techniques. Its cost should be within the range acceptable for other types of supervoltage-therapy equipment, including ^{60}Co units and linear accelerators. (BBB)

28539 EXPERIENCE WITH OHP IN THE MEGAVOLTAGE IRRADIATION OF 614 PATIENTS WITH ADVANCED MALIGNANT DISEASE. van den Brenk, H. A. S.; Madigan, J. P.; Kerr, R. C.; Cass, N.; Richter, Wendy; Torrens, Lynette (Cancer Inst. Board, Melbourne). pp 653-75 of Proc. Third Intern. Conf. Hyperbaric Med., Durham, N. C., Nov. 17 to 20, 1965. Washington, National Academy of Sciences, 1966.

Radiobiologic and clinical aspects of 4-MeV x irradiation of patients under oxygen at high pressure (OHP), i.e., at 4 atm, are discussed. The case material consisted mainly of recurrent and essentially incurable malignant disease to enable evaluation of different techniques, the incidence of oxygen toxicity, and local response of tumors in various sites, with particular reference to the effects of fractionation and protraction of radiation dose on tumor responses and tissue reactions. Tumor regression and clearance in most sites produced by irradiation in OHP was clearly superior to that resulting from treatment in air, being more predictable and complete, irrespective of histologic and other pathologic features purported to represent tumor radioresistance. Predictable effects of irradiation in OHP in terms of dose and fractionation, in respect to tissue tolerance and tumor effects, could be determined by the implementation of cell dose-survival parameters in clinical prescriptions. A dose of 3×1000 rad exceeded tolerance in both OHP and air, and dose fractionation prescriptions equivalent to 6×500 rad or 3×800 rad (or perhaps somewhat higher) provided acceptable tolerance by most tissues for large-volume irradiation. Doses of 500 to 1000 rad produced significantly more severe skin reaction in OHP than in air, and a 20-30% increase in dose is tolerated by skin air. Regardless of fractionation regimes used, it is suggested that air doses be increased by 20 to 30% relative to OHP to ensure that comparable tissue damage is produced before assessing relative tumor sterilization and therapeutic ratios. In lung cancer patients as in those with head and neck cancer, 3×1000 rad was not tolerated to the large volumes of lung, mediastinum, and adjacent cervical tissues. Radiation pneumonitis was invariably produced usually with onset 3 months after irradiation and causing death despite absence of tumor in the chest in most of the cases examined at autopsy. A dose of 3×800 rad was better tolerated; however pneumonitis and pulmonary fibrosis were still frequent at this biologically reduced level of dose. (BBB)

28540 PHYTOHEMAGGLUTININ AND IRRADIATION. Stefani, S. S.; Donnelly, W. J. (Veterans Administration Hospital, Hines, Ill.). Lancet, 1: 503(Mar. 4, 1967).

Controversy on the effects of phytohemagglutinin (PHA) on aplastic bone marrow prompted studies on this compound's possible in vivo radioprotective effect on human bone marrow. Four patients with bronchogenic carcinoma were studied. Two received PHA and subsequent large doses of localized irradiation, and 2 received irradiation alone. Five consecutive daily doses of 50 mg of PHA were administered by intravenous infusion. Local sternal irradiation (200 R daily) was started 3 days after the last dose of PHA. Four bone-marrow aspirations and bloodcounts were done, before and after the PHA regimen and at cumulative doses of 400 and 1000 R. During radiotherapy in both control and PHA-treated groups, a rapid drop occurred in the percentage of precursors of the myeloid series and erythroblasts, but this drop was more pronounced in the latter. At the 400-R level, the relative percentage of lymphocytes dropped in the controls and rose in the PHA-treated patients, and after 1000 R a relative increase was noted in all 4 patients, but it was more pronounced in those treated with PHA. It is suggested that PHA induces an additional increase in the relative percentage of bone marrow lymphocytes in patients receiving radiation therapy. This compound produces a radioprotective effect on human blood lymphocytes in vitro. Whether the relative increase of the marrow lymphocytes is a sign of enhanced resistance of these cells to x rays, or of their increased proliferation, or merely signifies greater loss of other bone marrow cell components remains to be seen. (BBB)

28541 THE USE AND CALIBRATION OF A SMALL WHOLE-BODY COUNTER FOR THE MEASUREMENT OF TOTAL-BODY POTASSIUM IN MALNOURISHED INFANTS. Garrow, J. S. (Medical Research Council, Jamaica). West Indian Med. J., 14: 73-81(June 1965).

The calibration, operation, potentialities, and limitations of a small whole-body counter used to measure ^{40}K, and thereby total K, in very small K-depleted children with an accuracy of ±8% are described. (TSS)

28542 MANAGEMENT OF THYROID PROBLEMS IN THE GERIATRIC PATIENT. Rossin, Herbert W.; Kadian, George; Hamburger, Joel I. (Northland Radioisotope Lab., Southfield, Mich.). J. Amer. Geriat. Soc., 14: 557-65(June 1966).

The safe use of ^{131}I in aged patients to control hyperthyroidism is illustrated by several case reports. Surgery is widely recommended as the best treatment for large multinodular goiters with hyperthyroidism, especially when there are signs of compression. However, radioiodine therapy may be safer as a means to reduce the goitrous mass and control hyperthyroidism. Although surgical management is relatively safe, the risks are greater in the geriatric patient, so the gentlest approach is desirable. The dose of radioiodine should be substantially in excess of that employed for younger persons or for those with smaller diffuse goiters. The elderly patient withstands prolonged hyperthyroidism poorly, whereas there is little risk in association with recognized and promptly managed hypothyroidism. Furthermore, the patient with a large toxic multinodular goiter will rarely, if ever, become hypothyroid. If compressive symptoms progress in spite of control of the hyperthyroidism, surgery can always be performed. Only 1 of 8 such patients treated with radioiodine ultimately required surgery. None became hypothyroid despite ^{131}I doses ranging from 20 to 50 mC. (BBB)

28543 EXTERNAL IRRADIATION: A SUCCESSFUL MODALITY IN PREVENTING HORMONALLY INDUCED GYNECOMASTIA. Gangai, Mauro P.; Shown, Thomas E.; Sieber, Paul E.; Moore, Charles A. (Letterman General Hospital, San Francisco). J. Urol., 97: 338-9(Feb. 1967).

The effectiveness and safety of x-ray-induced inhibition of mammary gland hypertrophy in men receiving estrogen therapy for metastatic prostate carcinoma were evaluated. Attempts were made to determine a low but adequate irradiation dosage schedule to prevent any local skin changes which might cause symptoms. Radiation to each breast was accomplished utilizing a standard 120-KV therapy unit, with a dose of 300 R administered to each nipple and

areola on alternate days for a total dose of 900 R in air. In the 10 patients treated in this manner, hormonal treatment, consisting of diethylstilbestrol 5 mg daily, was begun 2 days following the completion of irradiation. In follow-up evaluation from 3 months to 1 yr, a striking divergence from the usual clinical course was noted. No patients had symptoms referable to the breasts. In 3 patients minimal hypertrophy was noted 3 to 6 months following irradiation. In all patients there was a complete lack of nipple sensitivity, localized tenderness or pain. In no patients were there any skin changes secondary to irradiation. Thus, when given prior to the institution of hormonal therapy, the results were uniformly excellent. When similar or greater doses of x rays were administered to those with established gynecomastia, the results were uniformly poor. This technique had proven so effective and so innocuous that it is now offered to all new patients with prostatic carcinoma who are to be treated with hormones. (BBB)

28544 EFFECT OF STRUCTURAL ALTERATIONS ON THE PHOTOSENSITIZING POTENCY OF FUROCOUMARINS (PSORALENS) AND RELATED COMPOUNDS. Pathak, M. A. (Harvard Medical School, Boston); Worden, L. R.; Kaufman, K. D. J. Invest. Dermatol., 48: 103-18(Feb. 1967).

The sensitivity to uv radiation of skin of guinea pigs topically treated with furocoumarin derivatives was studied. Standard solutions of 8-methoxypsoralen and psoralen were applied to 2 separate sites, so that their effect could be compared with that of the compound under test. Thirty to 45 min after application of the solutions, the skin was irradiated with uv light (wavelength greater than 320 mμ), and 20 hr after irradiation the erythema at each test site was graded. The development of erythema in skin after topical application of these compounds in various concentrations and uv irradiation was used as an index of their photosensitizing activity. None of the compounds tested evoked a stronger erythemal response than unsubstituted psoralen. Methyl substitution at positions 4, 8, 4′, or 5′ of psoralen did not reduce the photosensitizing potency of the molecule, but methyl substitution at position 3 reduced it significantly. The photosensitizing activity of 4,5′,8-trimethylpsoralen, which is as potent as psoralen, decreased progressively when the methyl group at position 8 was replaced by $N(CH_3)_2$, CN, NH_2, or Cl groups. Hydrogenation of the furan ring of psoralen resulted in complete loss of photosensitizing potency. Several resorcinol derivatives induced very slight erythema. Thus, the ability to sensitize cutaneous tissue to light with wavelengths between 320 and 400 mμ is a unique characteristic of the psoralen-ring system. (BBB)

28545 FUNDAMENTAL ASPECTS OF RADIOISOTOPE SCANNING. Mallard, J. R. (St. Thomas's Hospital Medical School, London). Proc. Roy. Soc. Med., 58: 1058-62(Dec. 1965).

Some problems encountered in scanning are dealt with, and some new and projected developments in techniques and instrumentation are described. In photoscanning techniques, the size of an area of increased rate is often wrongly displayed and saturation occurs at the higher count rates; also there may be loss of detail at the lower count rates, for a chosen contrast setting. These effects are real and not only affect the apparent size of object perceived but also distort the count rate information. The effect is demonstrated using different density (or contrast) settings on a well-known commercial photoscanning machine when a phantom containing a 2-cm dia cylindrical tumor is scanned in conditions typical of ^{131}I-albumin cerebral scanning. The apparent size of the tumor varies considerably with the setting and it is obvious that the tumor could be missed at some settings. It is possible to show directly that the long-focusing collimators are much less depth dependent than the short-focusing ones and also that a gamma camera is capable of detecting tumors of a similar size to those detected by conventional mechanical scanners. Examination of the problem of the optimum energy of γ rays to use for brain tumor scanning indicates that energies in the region of 100 to 200 keV are probably best; below this, tissue absorption becomes important, while above it penetration of collimator septa spoils resolution. Use of and improvements in the gamma camera are discussed. The author is constructing an image-intensifying machine aimed at achieving a resolution of the order of a millimeter, ~10 times better than conventional scanners or present-day cameras. With this, small tumors and normal brain structures are to be displaced and dynamic studies of cerebral blood flow performed. (BBB)

28546 THERAPEUTIC PROBLEM OF LEUKOPLAKIA OF THE ORAL CAVITY. Baroncelli, G.; Questa, L. (Istituto del Radio "O. Alberti" Spedali Civili, Brescia, Italy). Riv. Ital. Stomatol., 20: 1290-306(Oct. 1965). (In Italian).

Changes in the oral mucosa and side-effects of irradiation are described in 44 patients treated for leukoplakia with ^{90}Sr. Advantages of ^{90}Sr β irradiation, with its low tissue range, over soft x-ray and Ra treatment are enumerated. The 2-mm range of ^{90}Sr β rays gives a maximum dose to the affected mucosa while sparing deeper, healthy tissues. The ^{90}Sr plaques used had a surface area of 0.7 to 4 cm^2 providing a dose rate at the surface of 500 to 3000 rep/min, allowing for short irradiation times. The daily dose in a single session was 2000 rep, which was repeated if necessary after 30 to 40 days. Rarely was a third dose required. Thus, most patients received a total of 4000 rep, 10 patients 2000 rep, and 3 patients 6000 rep. Relatively high doses may be required because of the low radiosensitivity of leukoplakia. It was estimated that the dose was attenuated to 50% of the surface dose at 1-mm tissue depth and to 20% at 2 mm. The submucosa and the corium were essentially spared of irradiation. In 7 to 15 days postirradiation, an erythematous, exudative reaction appeared at the site — an epithelite. Slight edema was apparent in the peripheral tissue. In cases which took a favorable course (75%), gradual re-epithelization occurred in the ulcerated area, without reappearance of leukoplakia, in 2 to 4 months. The consistency of regenerated mucosa was nearly always normal. In 30 cases a mild degree of atrophy of the irradiated mucosa was observed. In only one case was the leukoplakia unaffected. (BBB)

28547 LOCAL THERAPY OF TUMORS WITH IMPLANTATION OF PELLETS LABELLED WITH ^{32}P. Caldarola, L.; del Fante, F. M.; Abrate, M.; Nadali, L.; Calderini, P.; Badellino, F. (Univ., Turin). Cancro, 18: 542-56(1965). (In Italian).

Histologic and hematologic effects of radioisotope treatment and excretion levels of radioisotope were recorded in 15 patients undergoing treatment of oral cancer by implantation of pellets of ^{32}P interstitially. The total doses administered varied from 1 to 49 mCi, given in 1 to 7 treatments. Positioning of the pellets was checked radiographically. Three patients died, but in most of the other cases some palliative effect was obtained. In some patients detectable radioactivity occurred in blood and urine. In blood, it varied from 0.5 to 2.5% of the administered amount. No severe changes were noted in the course of ^{32}P therapy in hematologic parameters (platelet count, hematocrit, red and white cell counts) and in liver and kidney function. Histologic studies revealed destruction of cancer cell foci and replacement by connective tissue. Because of its short half-life time and pure β emission, ^{32}P in permanent implants was ideally suited for the cancer lesions described, which were in the oral mucosa. (BBB)

28548 INFLUENCE OF GAMMA WHOLE BODY IRRADIATION AND SOLCOSERYL ON THE POST-HEPATECTOMY LIVER REGENERATION (PRELIMINARY REPORT). Valderas, R.; Egana, E. (Univ. of Chile, Santiago). Nucl. Energy, 89-91(May-June 1967).

It was found that Solcoseryl (extract from calf blood — Solco Laboratories, Basle) did not stimulate the repairing process per se in rats submitted to 50R whole body irradiation after 60 to 66% hepatectomy. It enhanced the DNA content of the regenerating liver. From the histopathological standpoint this substance improves the local condition of liver inflammation. The mechanism of action is not yet properly understood. (UK)

28549 A MODEL FOR RADIATION INJURY. 6. WHOLE BODY INJURY. Sato, F.; Tsuchihashi, S. (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1190-8(Dec. 1966).

A model has been presented to explain consistently the whole body injury, the daily death distribution and the individual fluctuation in radiosensitivity. The whole body injury is easily estimated from the age specific mortality with the model. Quantitative relations among the above three factors are established. In general the maximum of the daily death distribution does not coincide with that of the whole body injury. The change in the age specific mortality is almost parallel with the whole body injury. (NSA of Japan)

28550 EFFECT OF TETRAHYDROFOLIC ACID ON SURVIVAL AFTER WHOLE BODY X-IRRADIATION. Sonka, J.; Slavik, K.; Pospisil, J.; Dienstbier, Z. (Charles Univ., Prague). J. Nucl. Biol. Med., 10: 101-3(July-Sept. 1966).

Tetrahydrofolic acid in a single intraperitoneal dose (0.5 mg/0.2 ml) was given to mice 10 minutes following x irradiation. A significant increase in the number of mice surviving after 30 days was observed, provided the radiation dose did not exceed 546 rad. Folic acid and dihydrofolic acid were ineffective. (auth)

28551 MEDICAL APPLICATION OF BETATRONS. Kobegyi, Ferenc. Atomtech. Tajek., 9: 573-6(1966). (In Hungarian).

Even though γ radiation sources are widely used in tumor therapy, β radiation is actually more effective medically because it is completely absorbed in a homogeneous medium at a well-defined distance from the surface, depending on its energy. Unfortunately, β emitters usually produce a mixed β−γ radiation and the spectrum of the β radiation itself is often very broad. Modern particle accelerators are able to produce high-energy, narrow-band electron beams which present many advantages. When a betatron is used, the patient may be irradiated in a relatively short time period, under clearly established operational parameters. By aim-

ing the beam precisely onto the tumor-affected area injury to the surrounding tissue may be minimized. On the other hand, the necessary equipment still represents a considerable investment in procurement and skilled labor needed for operation. (TTT)

28552 EFFECTS OF EXTRACORPOREAL IRRADIATION OF THE BLOOD ON LEUKEMIA: MALIGNANT LYMPHOMA OF CATTLE. Joel, D. D. (Brookhaven National Lab., Upton, N. Y.); Chanana, A. D.; Cronkite, E. P.; Greenberg, M. L.; Schiffer, L. M.; Schnappauf, Hp.; Stryckmans, P. A. Amer. J. Vet. Res., 28: 387-96(Mar. 1967). (BNL-9877).

Five cattle with malignant lymphoma were treated by extracorporeal irradiation of the blood (ECIB). Prior to ECIB, two of the cattle had normal lymphocyte counts, and two had a marked lymphocytosis. The 5th animal had lymphopenia at the time of procurement; however, the count had risen to within normal limits by the time ECIB was begun. The ECIB decreased the peripheral lymphocyte counts in all five cattle. In one of the cattle, the lymphocyte count was reduced from 70,000 to 3,000/cmm. by three treatments with ECIB. Peripheral lymph nodes did not significantly decrease in size despite prolonged treatment; however, in one of the cattle treated daily for more than a month, there was no further growth of lymph nodes. (auth)

28553 STUDIES ON TELECOBALT THERAPY. MEASUREMENTS OF DOSE DISTRIBUTION IN CONFORMATION RADIOTHERAPY. Okajima, Shunzo (Nagasaki Univ.); Sakuma, Sadayuki. Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1199-1207(Dec. 1966). (In Japanese).

Isodose curves in phantoms are made in the typical cobalt-60 conformation radiotherapy in various parts of the body. On the other hand, images of the beam-focus radiogram showing irradiated beam-focus region in actual clinical treatments are overlapped with the axial transverse tomograms at the identical magnification ratio. Each overlapping image is compared with the corresponding isodose curve. Such a method is very useful for monitoring the conformation radiotherapy. (NSA of Japan)

28554 ^{131}I IN THYROTOXICOSIS. Staffurth, J. S.; Young, Jennifer A. (Lewisham Hospital, London). Brit. Med. J., 1: 629(Mar. 11, 1967).

The effects of different doses of ^{131}I in the treatment of thyrotoxicosis are discussed. After 3500 rad (the so-called half-dose method) there was a marked reduction in the incidence of postirradiation myxedema, but this was at the expense of the time taken before final cure in many patients, though their symptoms were being controlled with an antithyroid drug. Concern is expressed for the delay in control of thyrotoxicosis that may occur in a few patients treated with ^{131}I, and for the fact that there may be more of these if there is a widespread use of lower dose methods. This delay in control is more frequent in severe cases, which can be particularly serious in those with heart disease. Larger doses of ^{131}I were given to these patients with the realization that an improvement in the numbers cured with one dose will be associated with a higher incidence of myxedema. A comparison should be made between treatment with a low dose of ^{131}I followed by antithyroid drugs and treatment with antithyroid drugs alone. It might then be found that the long-term relapse rate after antithyroid drugs would be markedly diminished by the prior administration of the small dose of ^{131}I. Such a scheme with a low incidence of myxedema could be used for mild cases, while in the more severe ones, and in the elderly, a larger curative course of ^{131}I could be given, accepting a higher incidence of myxedema as a lesser disadvantage than delay in early control and final cure. (BRB)

28555 POLYPLOIDY AND RADIOSENSITIVE BEHAVIOR OF HUMAN MALIGNANT CELLS IN VIVO. De, N. (Chittaranjan National Cancer Research Center, Calcutta). Brit. J. Cancer, 15: 54-60(1961).

The relation between the chromosomal population and radiosensitivity of epidermoid carcinoma cells of human cervix in vivo was studied. The 20 patients were treated with Ra (50 mg intrauterine and 50 mg in the vagina), and received at the point from where the tissue was taken, a total dose of 21,000 R in three applications according to the modified Stockholm technique. The interval between the first and the second application was one week and between the second and third application was 3 weeks. Each time the Ra was kept in position for 24 hr (total 2400 × 3 = 7200 mg-hr). About one month after completion of Ra treatment, supplemental x irradiation was given for a total tumor dose of 3000 R. Before and 1 month after completion of Ra irradiation, tissue from different regions of cervix was taken for histological assessment of the radiotherapeutic effect. Cases in which most cells had an average chromosome number of more than 60 were taken as the higher ploidy group; cases where most cells had an average chromosome number below 60 were taken as the lower ploidy group. Out of 20 cases studied, 8 exhibited higher ploidy whereas the remaining 12 showed a lower ploidy. In the higher ploidy group, all patients exhibited persistence of malignant cells in their cervical biopsies examined histologically 1 month after completion of Ra irradiation. Of these, 6 patients (75%) died within a year after completion of Ra treatment and 2 patients (25%) are still (30 months after irradiation) living and in good health. In the lower ploidy group, malignant cells were not found in the postirradiation histological sections of all patients. Of these 12 patients, 10 (83%) are still living and in good health while 2 patients (17%) died about 1 yr after completion of their treatment. (BBB)

28556 METABOLISM OF RADIOACTIVE ZINC IN THE LIVER DAMAGED WITH CARBON TETRACHLORIDE. II. AUTORADIOGRAPHIC STUDIES. Majewski, Czeslaw (J. Strus City Hospital, Poznan, Poland); Wysocki, Kazimierz; Owczarek, Lucjan; Kurnatowska, Aleksandra; Gorski, Szczesny. Acta Med. Pol., 7: 245-52(1966).

The distribution of radiozinc (^{65}Zn) in liver tissue damaged by a single administration of carbon tetrachloride was studied in rats by autoradiography. Livers from rats injected with carbon tetrachloride showed diffuse necrosis of liver cells in the lobules, passive congestion, and diffuse fatty degeneration of parenchymatous cells. Autoradiograms of ^{65}Zn in the liver of rats injected with carbon tetrachloride and rats injected with physiologic saline solution showed granular reduction of silver over the cytoplasm and nuclei of parenchymatous cells, especially near the bile canals and in the endothelium lining the liver sinuses. In control rats the number of reduced silver grains was greatest after 12 and 24 hr, diminishing gradually after 36 and 48 hr. Autoradiograms of ^{65}Zn in the livers of rats injected with carbon tetrachloride showed greatest numbers of reduced silver grains after 24 hr, and smaller numbers after 12 hr. After 24, 36, and 48 hr the distribution of the grains was less uniform, and even partly confluescent. After 12 hr, the reduced grains were smaller and more uniformly distributed. At longer intervals, the number of reduced silver grains diminished distinctly. Thus the liver of rats treated with carbon tetrachloride takes up less radiozinc than the intact liver, and ^{65}Zn is retained longer in the damaged liver. The intensity of the autoradiographic changes in these animals, in contrast to the control group, is higher after 36 and 48 hr. Presumably, this is a direct result of slower bile secretion by the damaged liver, as was observed in the preparations stained with hematoxylin and eosin. (BBB)

28557 THE EFFECT OF OXYGEN AND ANAESTHESIA ON RADIOSENSITIVITY IN VIVO OF EPITHELIAL CELLS OF MOUSE SKIN. Withers, H. R. (Mt. Vernon Hospital, Northwood, Eng.). Brit. J. Radiol., 40: 335-43(May 1967).

Using techniques for cloning skin epithelial cells in situ in mice it has been possible to estimate the x radiosensitivity of these cells in oxygen at three atmospheres, in air, and in anoxia. The effect of anaesthesia on the aerobic radiosensitivity is discussed. The data are compared with those obtained from observation of the gross response of skin and with results of irradiation in vivo of other cell types. An estimate of oxygen tension within epithelial cells of mouse skin has been made. (auth)

28558 RADIATION PROTECTION BY TOPICAL DMSO APPLICATION. Kim, Si E.; Moos, Walter S. (Univ. of Illinois, Chicago). Health Phys., 13: 601-6(June 1967).

Pre-irradiation, topical application of dimethyl sulfoxide to the tails of male CFW mice (50–60 days old) provided considerable radioprotection. The longer the immersion time in DMSO (up to 10 min) the better the protection. The DMSO pre-treated irradiated survivors showed less initial weight loss than the water-treated control animals. Treatment with dimethyl sulfoxide after irradiation had no effect on mortality. (auth)

28559 OBSERVATIONS ON THE PATIENT'S AND OPERATOR'S EXPOSURE DURING THE RADIOLOGICAL INVESTIGATIONS IN CARDIOLOGY. Barbaccia, F.; Roseo, B. (Ospedale Maggiore, Milan). Radiol. Med., 53: 269-86(Mar. 1967). (In Italian).

Exposure doses are reported for radiological cardiodiagnostical investigations on patients of different size (adults and children) and on the operator for different types of instruments and methods. Conditions which allow the greatest radiodiagnostic advantage together with the lowest exposure of the subjects are considered. Dosimetric checks of machines with the aid of image intensifiers and methods of investigation which make it possible to operate in conditions of safety are emphasized. (auth)

28560 CHRONOBIODOSIMETRIC CONSIDERATIONS ON SOME CASES OF CUTANEOUS RADIONECROSIS. Merli, E. (Univ., Genoa. Ospedale S. Giacomo, Novi Ligure, Italy). Radiol. Med., 53: 261-8(Mar. 1967). (In Italian).

A discussion of the use of the chronobiodosimetric system in radiotherapy, and a description of three cases of cutaneous radio-

necrosis with latency periods going from some months to nine years. An evaluation of the biodose factors responsible for the radionecrotic bioeffect and some conclusive considerations deriving from the biodosimetric analysis of the considered cases are presented. (auth)

28561 ABSOLUTE SENSITIVITY OF ELECTRON MICROSCOPE RADIOAUTOGRAPHY. Bachmann, L.; Salpeter, M. M. (Univ. of Innsbruck. Cornell Univ., Ithaca, N. Y.). J. Cell Biol., 33: 299-305(May 1967).

A calibration method is described for measuring absolute radioautographic sensitivities under various experimental conditions. Sensitivities to ^{3}H and ^{35}S radiation, i.e., ratio of developed grains to radioactive decays in the specimen, were determined with Ilford L4 and Kodak NTE emulsions. The highest values obtained in monolayers of emulsion were $1/8$ for ^{3}H and $1/21$ for ^{35}S. The influence of various experimental parameters on sensitivity is described, and the possibilities for quantitative electron microscope radioautography are discussed. (auth)

28562 PHYSIOTHERAPY OF KELOIDS WITH PARTICULAR REGARD TO RADIUM THERAPY. Bronzini, C. (Univ., Naples). Minerva Radiol., Fisioterap. Radiobiol., 12: 87-9(Mar. 1967). (In Italian).

After describing the various treatment techniques for the destruction of keloids, emphasis is laid on radium therapy. This technique is simple to use and complete cures are obtained without residual scars. (auth)

28563 PROGRESS IN RADIOACTIVE ISOTOPE SCANNING. Corey, Karin R.; Benua, Richard S. (Memorial Hospital for Cancer and Allied Diseases, New York). Med. Clin. N. Amer., 50: 689-700(May 1966).

Recent developments in technics, labeled materials, and instrumentation for use in clinical diagnosis are reviewed. The newer scanning methods depend on detection of small differences in count rates over an organ. The larger a given lesion is the easier it is to detect by scanning, as well as by other methods. However, the most useful application of scanning is for the detection of lesions that may not otherwise be observed. The equipment must, therefore, be designed to detect small lesions and small count rate differences. To obtain higher count rates and better accuracy in a given time it is possible to increase the amount of tracer given to a patient for a test, but this leads to increased radiation exposure to the patient. Current research work in nuclear medicine is aimed at finding tracers with such physical and biochemical characteristics as to minimize the radiation delivered into the patient's tissues, but allow high count rates. Technetium-99m with six-hr half-life, for example, has been used for brain, liver, and placenta scanning with excellent results. Improvements in detector design have led to the use of large and thick scintillation crystals, commonly 5 in. in dia and 2 to 3 in. thick. The development of large detectors to scan large organs or the entire body has led to the construction of total body scanners. Primary or secondary cancer lesions in many organs may be detected by scanning, i.e., mapping the distribution of a suitable radioactive material administered to the patient. The importance of detecting small differences is stressed. Scanners and various methods of scan displays, in particular digital recording, are discussed and illustrated. It was pointed out that with a photoscanner preselected settings are necessary which in retrospect may be found in error so that part or even the whole scan is lost. The digital scan eliminates this problem and in addition allows the detection of large and small count rate differences. Digital scanning provides data for quantitative scan interpretations in addition to the customary qualitative ones. Advances in detection of liver disease with digital scanning techniques are reviewed and attention given to the details of evaluation and interpretation of liver scans. (BBB)

28564 THE ^{85}Sr SCINTISCAN IN BONE DISEASE. DeNardo, Gerald L. (Veterans Administration Hospital, Palo Alto, Calif.). Ann. Int. Med., 65: 44-53(July 1966).

Results are described in 384 bone scintiscans performed on 123 patients with suspected bone lesions. The patients were scanned 24 to 72 hr after the intravenous administration of 25 to 100 μC of ^{85}Sr. Estimations are made of the radiation exposure of the patient in this procedure. Radiation exposure to the patient from a bone scan and roentgenographic skeletal survey is comparable and within acceptable limits assuming a reasonable indication for the diagnostic procedure. The radiation exposure from either the radioisotope or roentgenographic procedure depends on numerous technical and physiological variables. The radiation dose to bone from the intravenous administration of 25 to 100 μC of ^{85}Sr was calculated to be 0.4 to 4.6 RAD and the whole body dose to be 0.2 to 0.7 RAD. An anteroposterior roentgenogram of the pelvis results in ~0.2 RAD and a lateral roentgenogram of the pelvis results in 2.0 RAD to the ovary. Using these measurements, it is estimated that the bone dose from a roentgenographic skeletal survey is 0.1 to 4.0 RAD, depending upon the area examined. The skin dose similarly varies from 0.3 to 5.0 RAD. Radiation exposure of this magnitude is generally accepted as being associated with little or no genetic risk and no somatic effects. Results showed that the bone scan was particularly useful in evaluating patients with suspected metastatic and lymphomatous bone disease, osteomyelitis, and Paget's disease. It was also abnormal in chondrosarcoma, Ewing's sarcoma, giant cell tumor, multiple myeloma, and osteogenesis imperfecta. (BBB)

28565 RETINOBLASTOMA: REPORT ON 19 PATIENTS TREATED WITH RADIOTHERAPY. Paterson, M. W. (Glasgow Eye Infirmary); Charteris, A. A. Brit. J. Ophthalmol., 49: 347-58(July 1965).

Use of radiotherapy in various forms in 19 patients with retinoblastoma is described, with an account of precautions employed to prevent injury to the eye and the incidence of complications when they did occur. Successful radiotherapy depends on having a localized and reasonably sensitive lesion in such a position that an effective dose of radiation can be administered uniformly in a time depending upon the total dose required. The normal tissues in the vicinity should have a good blood supply, and the differential action of irradiation enable eradication of the tumor while causing minimum disturbance to normal tissue. These requirements are difficult to achieve in so delicate an organ as the eye, upon which the effects of high irradiation levels may be severe. One method is to place Rn seeds on the exterior of the globe at the required position. For some patients the seeds were stitched in place in an appropriate arrangement, but later, plastic envelopes containing the seeds were attached. In these applications the seeds must be near the sclera, so that the incident dose is high and above normal therapeutic levels if an adequate dose is to be received by the tumor. The anatomy is such that the achievement of a distance between the seeds and the sclera sufficient to even out the dose is impossible. Cases with multiple lesions, or those in which the growth is near or opposite the optic nerve, were dealt with with x ray therapy by small-angle fields. No severe erythema or other general or local reaction occurred. In one case, however, there was sloughing of the sclera, which may have been the result of a large dose of irradiation given near radon seeds. Of the 13 survivors, 5 had vision of 6/12 or better and 4 had vision of less than 6/12; 2 had both eyes removed. Five died of the disease and 1 died of intercurrent disease. Details of radiotherapy are given in each case. (BBB)

28566 CHANGES IN THE RADIORESISTANCE OF BACTERIA AFTER THE INHIBITION OF PROTEOSYNTHESIS IN THE PRE-IRRADIATION PHASE. Sedliakova, Milena; Slamenova, Darina; Stukovsky, R. (Inst. of Biology, Bratislava). Folia Microbiol. (Prague), 11: 169-72(May 1966).

An investigation was made of the course of increased radioresistance during temporary inhibition of protein synthesis before irradiation and of the course of the return to the initial condition. Escherichia coli, strain WP_2 (try^-), was irradiated with uv light, at a dose of 240 erg/mm. Protein synthesis was inhibited by the elimination of the essential amino acid from the culture medium. Changes in radioresistance were followed during 45 min of starvation and during the subsequent 45 min of restitution after the addition of the essential amino acid. The radioresistance of the cells showed a linear increase immediately after the removal of the essential amino acid, proportional to the duration of the inhibition of protein synthesis. The increase in radioresistance was shown to be reversible. After the addition of the essential amino acid there was an immediate decrease in radioresistance which was most marked in the first 15 min. Since the inhibition of protein synthesis, like the inhibition of RNA synthesis, may have synchronizing effect on the synthesis of DNA, the possibility cannot be excluded that the preirradiation inhibition of protein synthesis may have an effect on the degree of organization of DNA at the time of irradiation and thereby indirectly influence the survival rate of bacteria. (BBB)

28567 TREATMENT OF DIABETIC RETINOPATHY BY X-RADIATION OF THE PITUITARY. Oosterhuis, J. A.; Loewer-Sieger, D. H.; van Gool, J. (Wilhelmina Gasthuis, Amsterdam). Acta Ophthalmol., 41: 621-39(1963).

Complications of irradiation of the pituitary of 12 patients are described along with other clinical data. A literature review of pituitary radiosensitivity is also presented. Rotational x-ray therapy of the pituitary (3000 to 5900 R in 18 to 36 days) was performed for diabetic retinopathy. The changes in fundus lesions evaluated by funduscopic and photographic control are described. Far advanced retinopathy did not respond to the treatment. In 4 of 11 patients, signs of hypopituitarism developed after irradiation, consisting of decreased metabolic rate or disappearance of libido. Brain lesions occurred in 3 patients. The mental deterioration observed in 3 patients was presumed to be due to brain necrosis.

The clinical symptoms were forgetfulness, disorientation, drowsiness to lethargy, aphasia and ataxia, without the development of neurological focal signs. There is evidence that the brain stem and the thalamus are more susceptible to radiation damage than the cortical areas. In these patients there might have been a decreased radiation tolerance of the brain due to pre-existing vascular lesions. This was supported by the fact that contusions of the frontal lobe during hypophysectomy led to more hemorrhage and postoperative edema in diabetic patients than in other patients. Cerebral arteriosclerosis concomitant with retinal vasculopathy might have been responsible for the increased cerebral radiovulnerability in these patients; moreover, damage of the smaller blood vessels is a prominent feature of radiation necrosis. Brain necrosis was a very serious complication. Therefore, the trial series was terminated after a dozen patients. Small-field rotational ^{60}Co treatment, giving a more rapid dose decrease in the peripituitary region than the 240-kV irradiation used here, may be a safer way of irradiation, it is suggested. (BBB)

28568 KERATOPLASTY AND TRICHIASIS: THE PERMANENT DESTRUCTION OF EYELASHES BY RADIOTHERAPY. **Lamb, Adrian (Royal Perth Hospital, Australia). Trans. Ophthalmol. Soc. Aust., 24: 100-3(1965).**

Use of x radiation to permanently destroy the eyelashes in trichiasis in 63 patients is reported with attention to shielding of the eye and prevention of cataract and other complications. Amethocaine 1% was instilled into the eye, and a lead contact shield inserted. A lead protector was then placed over the eyelids, leaving only the lid margin with the affected eyelashes exposed. Low-energy, superficial x rays were used. The type of shields and lead covers used are illustrated. The untreated eye was also protected, for medico-legal reasons. The dose was varied according to individual requirements. In some cases 4 doses of 750 rad twice a week were given, or 3000 rad in 10 days. In one case 2 doses of 800 rad were separated only by one day, or 1600 rad in 3 days. These doses were biologically equivalent and in each case the lids became red, swollen and there was some slight desquamation. Other cases are treated with 3 or 4 doses arranged to have the same biological effect. Dangers of the therapy are discussed, particularly the hazard of irradiation cataract. A secondary and less important problem is the question of damage to tarsal cartilage by irradiation. The doses used in this therapy holds no risk to the lens or to the tarsal cartilage when the lead eye shield is in place. To increase the safety to the patient, an 18-carat gold shield was devised to put in the conjunctival sac, and this, because of its density, completely eliminated any risk to the cornea or the lens. Permanent loss of lashes was obtained in over 90% of the patients, and none developed any serious complications. Individual variations in radiosensitivity are discussed. Some patients experienced no discomfort, while others had mild to moderate discomfort. Three patients had very sore eyelids for up to 2 months after treatment, but no ill effects persisted. Two patients had mild local burns to the tarsal conjunctiva. Both cases healed after topical steroid therapy with no ill effects. (BBB)

28569 TREATMENT OF POST-IRRADIATION LESIONS OF THE URINARY BLADDER. Wojewski, Alfons; Roessler, Ryszard (Pomerianian Medical Academy, Szczecin, Poland). Polish Med. Sci. Hist. Bull., 8: 110-13(July 1965).

The therapeutic effect of tocopherol on late postirradiation lesions of the urinary bladder was examined in 96 patients. Patients presented the following symptoms: dysuria, frequency, polyuria, hematuria, pyuria, urinary incontinence, and pains in the hypogastrium and lumbar region. At cystoscopy, changes characteristic for chronic cystitis were revealed in most patients. Ulcerations were seen less frequently (9 cases). In 5 cases there was a constant flow of urine through a vesicovaginal fistula. Only in 12 patients was the capacity of the bladder as high as 200 ml; in the other patients it was in the range of 30 to 150 ml. Profuse hemorrhage from the bladder was observed in 3 cases. Best results with tocopherol were observed in cases where the anatomical changes in the bladder were least extensive. The relief was seen already after 3 to 5 injections of tocopherol. Patients passed urine less frequently, the pain decreased, and hematuria was subsiding. Usually, after one week leukocytes and erythrocytes disappeared from the urine. The ulcerations in 3 patients healed within 4 to 8 weeks. Less favorable results were seen in patients with widespread changes in the bladder. Urinary retention and the changes in the urinary tract did not subside under tocopherol therapy. The condition of the patients worsened from day to day so that it was necessary to resort to surgical means. In all, tocopherol caused improvement in 30 out of 70 patients with postirradiation lesions of the bladder. Additional administration of the antibiotics did not improve the results. (BBB)

28570 TREATMENT OF TUBERCULOSIS ON A COMBINED REGIMEN OF X-RAY IRRADIATION AND ANTI-TUBERCULOUS DRUGS. REPORT 4. AN ANIMAL EXPERIMENT AS TO THE EFFECTIVENESS OF A COMBINED REGIMEN OF LARGE-DOSE IRRADIATION OF X-RAY AND ANTI-TUBERCULOUS DRUGS. **Katagiri, Toshiro (Hirosaki Univ., Japan). Hirosaki Igaku, 17: 629-44(May 1966). (In Japanese).**

Data are given on the influence of a large-dose irradiation of x-ray (3060 r) on the anterior thoracic field of experimental tubercular guinea pigs with SM · INH · PAS treated or not. As a control, an irradiation of x-ray in usual dose (1530 r) was carried out in guinea pigs in the same way as mentioned above. Forty-two tuberculin negative guinea pigs, weighing about 500 g each, were inoculated with virulent human tubercle bacilli, and were then divided into 6 groups. 1st Group: no treatment, control group. 2nd Group: Large-dose irradiation of x-ray (single dose 200 r, total 3060 r) 3rd Group: Usual dose irradiation of x-ray (single dose 100 r, total 1530 r) 4th Group: SM · INH · PAS treatment. 5th Group: Combined regimen of large-dose irradiation and SM · INH · PAS. 6th Group: Combined regimen of usual dose irradiation and SM · INH · PAS. X-ray, SM, INH and PAS were administered for 19 weeks, beginning 7 weeks after the inoculation of the tubercule bacilli. The results and conclusions are as follows: A large-dose irradiation of x-ray without chemotherapy is not effective but dangerous to experimental tuberculosis. The combined effects of large-dose irradiation and chemotherapy are able to improve experimental tuberculosis, and to control tuberculous inflammation in tissues distinctly. A usual dose of x-ray irradiation itself, is effective for experimental tuberculosis. A combined regimen of the usual dose irradiation itself and the SM · INH · PAS treatment is better than both the usual dose irradiation itself and the SM · INH · PAS treatment itself, for treating experimental tuberculosis. (auth)

28571 THE MALIGNANT UTERUS YESTERDAY, TODAY, AND TOMORROW. **Stallworthy, John (United Oxford Hospitals). J. Amer. Med. Ass., 195: 465-70(Feb. 7, 1966).**

Development of a combined preoperative irradiation and surgery program for treating cervical cancer is traced, with a description of radioinduced complications and their prevention. Experiments in mice demonstrated that the growth of implanted malignant cells is impaired or prevented by irradiation of both the tumor and the tissues into which the cells were seeded. If only one area was irradiated, fewer cells survived when the seed bed and not the tumor was treated. The reason for this appears to involve tissue defensive mechanisms which can be made more powerful by irradiation in optimum doses. This helps explain why malignant implants are seldom seen in the operation field after preliminary radiation therapy. In early clinical studies hysterectomy with lymphadenectomy was performed after 3 applications of Ra using a dose of 7200 mg/hr, or 8000 RAD at point A. Steps were taken to reduce to a minimum the trauma to irradiated tissues, and particularly to those areas prone to fistula formation even without preoperative irradiation. The structures at greatest risk are the ureter and baldder, and fistulas are usually secondary to post-operative necrosis following interference with the blood supply. As to the time interval between the application of Ra and the operation, 6 weeks after the first application, or 3 to 4 weeks after the third, proved safe and gave rise to no major difficulties. With the precautions described there was no increased mortality or serious morbidity following surgical treatment of the irradiated tissues. (BBB)

28572 THERAPEUTIC TRIALS WITH METHENOLONE IN DISORDERS OF PROTEIN METABOLISM IN PATIENTS TREATED BY RADIOTHERAPY ALONE FOR CANCERS OF THE HEAD AND NECK. **Batani, J. P.; Rathle, C. (Fondation Curie, Paris). Sem. Hop. Paris, 41: 3024-6(Dec. 14, 1965). (In French).**

Disturbances in protein metabolism as an aftereffect of whole-body irradiation and their correction are considered. Tissue regeneration and, therefore, general resistance of the irradiated organism, is dependent on healthy protein metabolism. Disturbances of protein metabolism observed in patients under localized therapy for malignant tumor of the head and neck result mainly from severe secondary mucosal reactions to irradiation making food ingestion almost impossible, favoring protein catabolism over anabolism. Recently a new anabolic steroid, methenolone (1-methyl-Δ^1-androsthenolone), has appeared which stimulates protein synthesis. The present study included 74 patients who had received high ^{60}Co radiation doses and were suffering from protein imbalance. They had experienced dysphagia from oral mucosal irradiation reactions. Injection of methenolone every 7 to 10 days for 2 to 3 months was followed by improvement in protein nutrition in 73% of cases, as manifested by weight increases, a decrease in 24-hr urinary N excretion, and an increase in total plasma protein levels. Among the subjective physical signs of improvement were: a gain of appetite and an increased feeling of well-being. No secondary hormonal effect was observed and tolerance of the drug was generally good. (BBB)

28573 A COMPARATIVE ANALYSIS OF THE ACCURACY OF THE ^{99m}Tc PERTECHNETATE BRAIN SCAN: FOLLOWUP OF 1000 PATIENTS. Witcofski, R. L.; Maynard, C. D.; Roper, T. J. J. Nucl. Med., 8: 187-96(Mar. 1967).

A review of 1000 patients scanned with ^{99m}Tc pertechnetate for intracranial lesions produced 148 positive scans. In the series 72 out of 95 patients with proven intracranial neoplasms (81.5%) had positive scans. The distribution of these positive scans with respect to the various types of neoplasms was presented, as well as comparative analysis with ^{197}Hg and ^{203}Hg chlormerodrin brain scanning. Positive scans were obtained in a number of non-neoplastic conditions. A comparison of the accuracy of the brain scan was made to other diagnostic tests: the echoencephalogram, the electroencephalogram, skull films, the arteriogram, and the pneumoencephalogram-ventriculogram. (auth)

28574 AN INVESTIGATION OF THE COMBINED EFFECT OF SEVERAL COMPOUNDS AND UV-IRRADIATION ON ACTINOMYCES FLORIDAE (A PRODUCER OF FLORIMYCIN), STRAIN 4034. Romanova, N. B. (All-Union Research Inst. of Antibiotics, Moscow). Genetika, No. 2, 168-72(Feb. 1967). (In Russian).

A preliminary treatment of the Actinomyces floridae spores, the producer of florimycin, with 2 percent solutions of nitrosomethylurea, nitrosoethylurea and thiourea eliminates the lethal effect of uv rays and ensures a lower frequency of morphological mutations induced by uv rays in the organism as compared to the theoretically expected total value. A preliminary treatment of the spores of Actinomyces floridae with 2 percent solutions of guanidine and urea has shown a slight protective effect of the former compound and the absence of any such effect of the latter compound. (auth)

28575 RESISTIVITY OF SPORES TO ULTRAVIOLET AND γ RADIATION WHILE EXPOSED TO ULTRAHIGH VACUUM OR AT ATMOSPHERIC PRESSURE. Silverman, Gerald J.; Davis, Norman S.; Beecher, Norman (Massachusetts Inst. of Tech., Cambridge). Appl. Microbiol., 15: 510-15(May 1967).

Viability studies were conducted on microbial spores subjected to ultrahigh vacuum (UHV) in the 10^{-9} to 10^{-10} torr range. After 5 to 7 days in vacuum, they were exposed to ultraviolet (uv) or the γ radiation either while still under vacuum or in the presence of dried air. Among the four test organisms subjected to UHV and ultraviolet radiation, Aspergillus niger was the most resistant; Bacillus megaterium, B. subtilis var. niger, and B. stearothermophilus were about equally less resistant. All four spores were more sensitive to ultraviolet radiation when UHV-dried than when desiccant dried. Of the four test organisms subjected to UHV and γ radiation, B. megaterium proved to be the most resistant; A. niger was the least resistant; and the remaining two organisms were of intermediate resistivity. All four organisms were less radiant resistant when UHV-dried than when irradiated in their normally hydrated state, and all showed an increased radiosensitivity after vacuum drying when oxygen was present. In addition, spores of B. subtilis var. niger and A. niger were less radiosensitive when UHV-dried and irradiated in vacuum than when wet and irradiated in air, whereas the reverse relationship was observed for the remaining two organisms. Based on the fact that microbial contaminants can be readily shielded from uv light by soils, metal particles, etc., and considering that the levels of ionizing radiations reported to be present in interstellar space are generally lower than those used in these experiments, the decrease in radioresistivity imparted by UHV drying is not of a sufficient magnitude to sterilize dependably portions of a spacecraft while on a mission. (auth)

28576 PARIETOGRAPHY IN CANCER OF THE RECTUM. Shniger, N. U.; Fain, S. N. (Ministry of Public Health, Moscow). Vop. Onkol., 13: 83-7(1967). (In Russian).

Modification of a roentgenological method of investigation of the rectum is reported. The method combines the retropneumoperitoneum with simultaneous inflation of the rectum. Fifty-two patients with cancer mainly of the medial and upper ampullary portion of the rectum were investigated. No complications were observed in using this method. Parietography contributed to precise diagnosis of the rectal cancer, and in a number of cases allowed determination of the character and form of the cancerous tumor growth, its size, and the relationship with neighboring organs and tissues. Sometimes metastases were detected in lymph nodes of pararectal cellular tissue. The method is valuable for evaluating prognosis of surgery. (auth)

28577 SCANNING RADIOACTIVE PHOSPHORUS IN BONE METASTASES FROM CANCER OF THE PROSTATE. Simon, Norman; Feitelberg, Sergei; Glickman, Stanley I. (Mount Sinai Hospital, New York). J. Urol., 97: 523-5(Mar. 1967).

The development of sensitive scanning equipment made it possible to locate the ^{32}P in bone by detecting secondary radiations from the interaction of the β particles with the tissue. The conversion of energy from this interaction is extremely inefficient, but the resultant bremsstrahlung is intense enough to be detected when therapeutic doses of ^{32}P are administered. In the scanning procedure, a scintillation crystal that detects radiation was moved slowly over the body, and the intensity of radiation emitted was recorded on film or paper to show the relative distribution of radiation within the patient. An illustration is given of a photoscan of the pelvis after intravenous injections of ^{32}P. There was increased uptake of isotope in metastases. The scan was made with a spectrometer setting at 75 to 300 KV to detect bremsstrahlung. The detection and mapping of ^{32}P in bone by scanning provides an in vivo method of following the distribution of the isotope. By repeating examinations at appropriate intervals the dynamic uptake of ^{32}P in metastatically involved bone can be studied. The effect of an internally deposited isotope depends on the doses in the target tissue. This dose is in turn dependent on the differential uptake and the length of time the isotope spends in various pools of the body. Such investigations may be made by scans of bremsstrahlung from ^{32}P. (BBB)

28578 ARTERIOGRAPHIC AND SCINTILLOGRAPHIC CONTROLS IN REGIONAL INTRA-ARTERIAL THERAPY OF MALIGNANT TUMORS WITH MICROSPHERES OF RADIOACTIVE RESIN. Caldarola, L.; Badellino, F.; Calderini, P.; (and others) (Istituto di Oncologia, Turin). Minerva Med., 57: 1822-50 (May 19, 1966). (In Italian).

An improved technique for local radioisotope therapy is described in which scintigraphy is used to evaluate localization of the injected dose. Treatment was carried out in 165 cases using mCi doses of ^{32}P and μCi amounts of ^{51}Cr-labeled resin microspheres ~30 μ in diameter. Most of the tumors treated were of the tongue, lung, breast, pelvis, or limbs. In some cases a whole-body scanner was used for dosimetric control. In most cases an optimal concentration of radioisotope in the target area was obtained with an adequate distribution of radioactivity. In treatment of tumors of the head region, doses of 3 to 5 mCi of ^{32}P and 200 to 500 μCi ^{51}Cr, in 8000 to 12,000 microspheres, were used. Accurate visualization of the treatment zone was also obtained by arteriography. Doses given in various other treatment areas are shown, along with the scintigraphic patterns obtained. (BBB)

28579 THE MANAGEMENT OF PTERYGIA: A THIRD REPORT ON A COMBINED SURGICAL-IRRADIATION TECHNIQUE. Haik, George M. (Louisiana State Univ., New Orleans). Amer. J. Ophthalmol., 61: 1128-34(May 1966).

An improved technique of management of pterygia was devised, consisting of the standard excision operation combined with irradiation by the ^{90}Sr applicator. A supplementary inversion of the stump of the excised pterygium is carried out when the lesion is large or recurrent. The surgical technique plays an important part in the improved results attained, but the use of β irradiation to the surgical field is believed to be more important. The dose of irradiation (about 900 RAD) is as small as will obtain the desired results, to avoid the risk of radiation cataract formation. Surgery and irradiation should be performed as early as possible. Application of β irradiation to the surgical field is necessary in the course of operation, before the capillaries which favor recurrence have any chance to bud. Irradiation halts the reparative process before it begins. The face filters of the ^{90}Sr applicator (0.002 mm of stainless steel and 0.01 mm of aluminum) permit only 3% of the β particles from ^{90}Y to pass through them. The spectrum of the applicator, therefore, after it passes through 100 mg/cm^2 of filtration, is essentially that of a pure β emitter. The ^{90}Sr applicator used was calibrated at 55 rep/sec. Irradiation of advanced pterygia without surgery is not recommended. Vessels visible to the naked eye, whether superficial or deep and whether old or new, require dangerously high doses of irradiation, which may produce local necrosis and telangiectasis. The risk of damage to the lens is far greater than with early operation and immediate irradiation. (BBB)

28580 THE VASCULAR REACTION OF HUMAN SKIN TO IRRADIATION WITH LONG WAVE ULTRAVIOLET (366 mμ) AND VISIBLE LIGHT (405 AND 436 mμ). Rottier, P. B. (State Univ., Utrecht). pp 329-30 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

In an attempt to reproduce immediate pigmentation, that is said to require doses of long wavelength uv 500 to 1000 times larger than those that cause the normal sunburn reaction with short wavelength uv, the light of a strong mercury arc was focused on the skin by glass lenses after passage through filters. Measures were taken to prevent any short wavelength uv reaching the skin. During an irradiation period of 1 min, doses at 366, 405, and 436 mμ were about 1000 times the short-wavelength sunburn dose; this amounted to a radiation dose of ~25 mw sec/cm^2 on the upper arm. During an irradiation of 1 min the contamination with short-wavelength uv was less than 0.0001 of a sunburn dose. The reaction of the skin (mostly of the upper arm) of about 40 patients was stud-

ied at these three wavelengths and with irradiation times as long as 20 min (doses up to 300 w sec/cm^2). Visible reactions of three types were noted. In 80% of the patients an erythema was visible immediately after irradiation; this lasted 3 to 5 min and had no after effects. In 20% of the patients an erythema appeared after a period of several hours; this reaction resembled a normal sunburn reaction. In 70% of the patients a bluish-grey discoloration was visible immediately after irradiation; this lasted for a few hours. The third type reaction was not immediate pigmentation, since it disappeared completely when pressure was applied. When the original bluish-grey discoloration diminished, a faint yellow or brown color remained. Some days later, if sufficient irradiation had been given, it was succeeded by pigmentation. If the skin was treated with naphazoline and sulfas atropini development of the bluish-grey discoloration was prevented. This third reaction was named blue hyperemia of the deeper vessels of the skin. The faint discoloration during or after application of pressure was presumed to be caused by cellular infiltrations around the vessels involved. It was considered that all primary visible skin reactions caused by irradiation with uv or visible light were vascular dilations. (BBB)

28581 RADIATION-RELATED LEUKEMIA IN HIROSHIMA AND NAGASAKI 1946–1964. II. OBSERVATIONS ON TYPE-SPECIFIC LEUKEMIA, SURVIVORSHIP, AND CLINICAL BEHAVIOR. Bizzozero, Joseph O. Jr.; Johnson, K. G.; Kawasaki, S.; Ciocco, A.; Toyoda, S. (Atomic Bomb Casualty Commission, Hiroshima). Ann. Internal Med., 66: 522-30(Mar. 1967). (TID-23519).

Maximal incidence rates for leukemia occurred during 1950 to 1954, especially for chronic granulocytic and acute lymphocytic leukemias, in those who were 0 to 29 yr of age at the time of the bombings and who were exposed at 0 to 1500 m. This initial period was followed by a transitional period of radiation effect during 1955 to 1959 characterized by elevated rates of acute granulocytic leukemia in those persons 30+ yr of age at the time of the bombings and exposed at 0 to 1500 m. During the 1950 to 1959 period, leukemia occurred predominantly in males exposed 0 to 1500 m. In particular, chronic granulocytic leukemia during 1950 to 1954 occurred mostly in male subjects who were 0 to 29 yr of age at the time of the bombings and exposed at 0 to 1500 m. No significant clinical or symptomatologic differences appeared to separate those cases of leukemia exposed at 0 to 1500 m from those exposed at 1501 to 10,000 m. The findings of elevated incidence rates for both acute lymphocytic and chronic granulocytic leukemias in the young age group and granulocytic leukemia, acute and chronic, in the older age group suggests that age at the time of exposure and possibly dose are just two of several factors that may determine the type of specific leukemia response in human. Experimental investigations in the mouse and other experience with humans tend to support these observations. (BBB)

28582 PROBE FOR TUMOR DIAGNOSIS. (to Gamma Optikai Muvek). British Patent 1,071,410. June 7, 1967. Priority date June 24, 1963, Hungary.

A probe for tumor diagnosis is described which comprises a radiation detector that is secured in a device such that the pressure on the measuring surface of the detector is regulated. (B.G.D.)

28583 APPARATUS FOR THE FLUOROSCOPY OF PARTS OF THE MOUTH CAVITY. (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,068,414. May 10, 1967. Priority date July 9, 1963, Austria.

An apparatus for the fluoroscopy of parts of the mouth cavity includes a radiation source comprised of a radioactive substance emitting weak γ radiation and a holder for the radioactive substance. The source is adapted for partial insertion into the mouth cavity to locate the radiation adjacent to a particular part of the cavity to be examined. A fluorescent substance is used to convert the emergent radiation into a visible image to provide for immediate and continuous observation of the particular part. An apertured shield is located in an adjustable position relative to the source to permit the emergence of the radiation through any one of a number of apertures of differing sizes. (B.L.M.)

Radiation Effects on Animals

Refer also to abstracts 28335, 28340, 28347, 28397, 28409, 28453, 28472, 28476, 28552, 28581, and 28701.

28584 (AFRRI-SP-66-23) THE ACUTE MORTALITY RESPONSE OF MONKEYS (MACACA MULATTA) TO MIXED GAMMA-NEUTRON RADIATIONS AND 250 KVP X RAYS. Stanley, Richard E.; Seigneur, Leslie J.; Strike, Thomas A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec. 1966. 15p. (CONF-660614-10).

From 3rd International Congress on Radiation Research, Cortina, Italy.

One hundred and forty young adult male and female monkeys (Macaca mulatta) were irradiated with single whole-body doses of mixed gamma-neutron radiations or 250 kVp x rays. The 80 mixed gamma-neutron and 60 x irradiated animals were uniformly exposed in groups of 10 to graded doses delivered at the rate of 16 and 20 rads per minute respectively while being slowly rotated in an upright position. Referenced to the midline of a Plexiglas monkey phantom, $LD_{50/60}$ values of 503 ± 20 rads and 381 ± 13.5 rads were calculated for x-ray and mixed gamma-neutron radiations, respectively. Using 250 kVp x ray as the reference source, the acute mortality RBE of mixed gamma-neutron radiations as determined by the ratio of midline rad doses in a Plexiglas phantom was 1.3. Ninety-three percent of the deaths occurred in the 10 to 19-day interval resulting in a mean survival time of approximately 15 days with no deaths occurring after 28 days. From the comparative data on clinical observations, survival time, gross pathology of the decedents and serial hemograms of the survivors during the 30 to 60-day intervals, no significant difference in response was apparent in the x- or mixed gamma-neutron irradiated monkey. Further, death, with one exception, was concluded to be principally attributable to hematopoietic injury with infection as the major contributing lethal factor. (auth)

28585 (BNWL-247) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, MARCH 1966, ON AEC DIVISION OF BIOLOGY AND MEDICINE PROGRAMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1966. Contract AT(45-1)-1830. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of research conducted during the report period are summarized. Radiation effects were analyzed in isolated gut segments from irradiated rats, and γ-radiosensitivity of flour beetles was determined. Radionuclide toxicity studies were concerned with: factors affecting the toxicity and metabolism of ^{137}Cs in rats and ^{65}Zn concentrations in the clam Anodonta nuttaliana and the green shore crab Hemigrapsus oregonensis; levels of collagen precursors in lungs of rats maintained on cyanide-treated drinking water for several months; and metabolism of inhaled $^{238}PuO_2$ aerosols in dogs. Methods of obtaining mutants of Neurospora that are unable to transport tryptophan were sought. Environmental studies included: an aerial census of Canadian geese within Hanford boundaries on March 22, 1966; plant uptake of radionuclides; ^{65}Zn, ^{51}Cr, and ^{131}I levels in Columbia River organisms; geologic investigations at the Hanford Project; effects of temperature on metabolism in liver of trout; and models for the prediction of the transport of radionuclides. Consideration of radioisotopes as particulates and volatiles, three scavenging test at the Rimrock Lake test time, meteorological and fallout cloud data for shot Smoky, and diffusion experiments at South Vandenberg in connection with Operation Mountain Iron contributed data on atmospheric radioactivity and fallout. Radiological and health physics problems were centered around: whole body counting, development and calibration of an x-ray/alpha counter; preparation of ^{143}Pm; sensitivity of the γ absorbed-dose calorimeter; tests of the 100 cc ion chamber in fast neutron fields; dose measurements with tissue-equivalent spherical proportional counters compared with doses calculated from neutron flux; and film dosimetry calibration. Improvements in radiation monitoring instruments and development of a detector for multidimensional γ ray spectrometry are discussed. Continuation of studies of ^{55}Fe body burdens in the Seattle area resulted in observations that: females contain more ^{55}Fe than males; older people contained more than younger people; and males over 170 lbs in weight had higher levels of ^{55}Fe in their blood than those under 170 lbs. (H.G.D.)

28586 (BNWL-SA-1144) PARTICLE SIZE AND ANIMAL AGE AS FACTORS IN EVALUATING HAZARDS FROM INGESTED RADIONUCLIDES. Sikov, M. R.; Mahlum, D. D.; Mahony, T. D.; Sullivan, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 20p. (CONF-660917-8). Dep. CFSTI.

From Gastrointestinal Radiation Injury Symposium, Richland, Wash.

Adult male rats were used in experiments with simulated reactor fuel particles. The particles were about 1 mm in dia, consisted of depleted uranium in a graphite matrix, and contained about 800 μCi of ^{89}Sr chloride. Particles were administered by stomach tube and time of excretion of particles was determined by monitoring the feces. Glass dosimeters were inserted in the mesenteric fat along the outer surface of the gastrointestinal tract prior to particle administration. The rats were killed, the dosimeters read, and the gastrointestinal tracts prepared for histological studies. The feces contained 90% of the free ^{89}Sr. Histological findings are tabulated,

using an arbitrary grading system, the most severe lesions showing partial denudation of the epithelium and ulceration. Results of glass dosimeter readings show a good correlation between measured radiation doses and incidence of injury to the corresponding segments of the gastrointestinal tract. In other experiments, suspensions of plutonium oxide particles of 3 different size distributions were administered by stomach tube to adult and 6-day-old rats. Three to 7 rats were killed at intervals up to 21 days after administration. The gastrointestinal tracts were removed, cut into segments, and prepared for liquid scintillation counting. The tabulated results show that the fraction found in the ileum and colon was consistently greater and the cecal content lower in the infant rats than in the adults. The passage time of $^{106}Ru-^{106}Rh$ was determined in adult and 6-day old rats. Rats were sacrificed at $\frac{1}{2}$, 1, 3, 6, 16, and 24 hours after administration. The intact gastrointestinal tracts were excised. The stomachs were cut into 4 segments; the intestines were divided into 1-cm segments and assayed in a gamma scintillation spectrometer. The initial rate of release of $^{106}Ru-^{106}Rh$ from the stomach was slightly greater in the adult than in infant rats. Nearly 80% of the activity was cleared within 2 hrs; small amounts were present until 16 hrs. The neonatal rats retained a substantial amount up to 24 hrs. The material remained in the last half of the small intestine a much longer time in juvenile animals than in adults. The times of entry into and patterns of passage through the large intestine were similar although the adults attained greater peak levels. Observations from these studies suggest that the hazard from ingested radioactive particles may be greater in the infant than in the adult. (H.L.W.)

28587 (BNWL-SA-1260) EFFECTS OF ACUTE IONIZING RADIATION IN SELECTED PACIFIC NORTHWEST RODENTS. O'Farrell, Thomas P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 12, 1967. Contract AT(45-1)-1830. 24p. (CONF-670503-8). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

The $LD_{50/30}$ values for five species of rodents exposed to an acute dose of γ-radiation were: Microtus oregoni, 652 rad; M. miurus, 846 rad; Perognathus parvus, 862 rad; Peromyscus maniculatus, 879 rad; C57BL X BALB hybrid Mus, 881 rad. Cricetid rodents were not more resistant than Murid mice. There was no apparent relationship between radiation resistance and either taxonomic affinities or adaptations to stresses of rigorous environments. It was postulated that the lowered resistance of Microtus oregoni may be related to its low chromosome complement (♂♂ 17/18, ♀♀ 18/17). Decedents showed evidence of hematopoietic death with secondary infections and hemorrhages of varying degrees. Mean survival times of decedents appeared to be directly related to radiation resistance at doses ≤1000 rad. Weights of treated animals decreased until 7 to 14 days postirradiation, after which time they returned to near normal values by 21–30 days. A loss of ≥15% was apparently lethal: no animals lost that percent of their initial weights and lived. Secondary effects included prolonged gonadal atrophy in Peromyscus, and extensive depilation and loss of muscle tone in the cheek pockets of Perognathus. (auth)

28588 (COO-1024-23) A COMPARISON OF THE CYTOLOGICAL EFFECTS PRODUCED BY IONIZING RADIATIONS OF DIFFERENT L.E.T. Technical Progress Report. [Riley, Edgar F.] (Iowa Univ., Iowa City. Radiation Research Lab.). Mar. 1967. Contract AT(11-1)-1024. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

RATS—mitosis in cell populations of normal lens epithelium in
X RADIATION–effects on whole lens in rats
X RADIATION–effects on cell populations in lens of rats, effects of half shielding on
X RADIATION–effects on whole lens in eyes of rats, effects of dose fractionation on. (H.G.D.)

28589 (HW-42540) TRIPLE RADIATION ASSAULT ON DEBILITATED LAMBS. George, L. A.; Hackett, P. L.; Bustad, L. K. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 1955. Contract W-31-109-eng-52. 11p. DTIE.

Exposure of debilitated lambs to a triple radiation assault consisting of 50 or 100 R of whole-body x irradiation, oral administration of 200 or 650 μCi ^{131}I, and 2000 or 16,000 rads of β irradiation of localized areas of skin resulted in transient lassitude, discoloration and scarring of the β irradiated lesions of the skin, and a marked leukocyte depression. Six months after the radiation assault the animals were alert and in good physical condition. (auth)

28590 (LA-DC-8780) ORGANIC SCINTILLATION DETECTORS AND THEIR USE IN THE STUDY OF BODY COMPOSITION. Anderson, Ernest C. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 62p. (CONF-670519-1). Dep. CFSTI.

From Body Composition Conference, Columbia, Mo.

For the measurement of total potassium content of human subjects, it was shown that large organic scintillation counters are capable of a precision of ±3 g K (one standard deviation) under routine conditions. With special care, a precision of 1 g K was approached. The absolute accuracy may be comparable under favorable conditions, but the error can be larger than 8%. Sources of error include counting statistics, instrument instability, contamination, and calibration errors. General methods of detecting and evaluating these errors are discussed, and some results obtained with human counters are given. Animal measurements are undoubtedly more difficult because of the more serious problem with control of contamination and, in some cases, because of the larger mass. (auth)

28591 (NYO-2740-4) ANNUAL REPORT ON RESEARCH PROJECT. (Columbia Univ., New York. Radiological Research Lab.). Jan. 1, 1967. Contract AT(30-1)-2740. 220p. Dep. CFSTI.

MAIZE—radiation dosimetry in seeds of, monoenergetic neutron
RADIATION DETECTORS, IONIZATION CHAMBERS—design for neutron dosimetry; use of gas multiplication, for dosimetry
STYRENE POLYMERS—fast neutron attenuation and scattering in
PROTONS—dosimetry of 2.2 GeV
NEUTRONS, FAST—dosimetry for genetic studies in Drosophila
COMPUTER PROGRAMS—for testing of interpolation algorithms; design of graphic output package for; integration into existing monitor systems; translation for operation within IBSYS Monitor System, FORTRAN II and IV for IBM 7094
RADIATION DETECTORS, PROPORTIONAL—design and use of spherical tissue equivalent; use for measuring pulse spectrum produced by α particles from collimated and uncollimated sources
X RADIATION—measurement of 3 keV, using spherical proportional counters; effects on Chinese hamster fibroblasts, method for photography of; effects on eyes of rat embryos
ALPHA PARTICLES, PROTONS—attenuation in tissue equivalent gas and water
CURIUM-244—alpha emission by, attenuation of, in tissue
PLATING—operation of device for, of radioactive materials
X-RAY SOURCES—design and testing of low voltage
MICE—radioinduced lens opacification in, RBE for fast neutron; radioinduced teratogenesis in fetal, dose dependency of x
BACTERIA—Escherichia coli, radioinduced lethality and mutations in, effects of capacity for dark repair on uv
CELLS—radioinduced inactivation of, model for recovery from effects of dose fractionation on
FERTILITY—radiation effects on, of female mice, effects of in utero exposure on x (H.G.D.)

28592 (NYO-3096-21) PROGRESS REPORT [ON GENETIC LOAD IN NATURAL POPULATION IN RELATION TO GENETIC BACKGROUND], JUNE 1, 1966–JUNE 1, 1967. Dobzhansky, Theodosius (Rockefeller Univ., New York). Contract AT(30-1)-3096. 13p. Dep. CFSTI.

FRUIT FLIES—genes of Drosophila pseudoobscura, effects of zygosity on expression of lethal
GENETICS—analysis in natural populations of Drosophila pseudoobscura
RADIATION—effects on proportion of lethal second chromosomes in Drosophila melanogaster
CHROMOSOMES—effects on fertility and fecundity of Drosophila melanogaster, effects of zygosity on lethal (H.G.D.)

28593 (ORO-2903-32) STUDIES IN THE USE OF IONIZING RADIATION AS STIMULI. Progress Report, June 1, 1966–May 31, 1967. Smith, James C. (Florida State Univ., Tallahassee. Dept. of Psychology). Contract AT(40-1)-2903. 18p. Dep. CFSTI.

RATS—Radioinduced conditioning for saccharin avoidance in, effects of anesthesia on x
X RADIATION—use as warning stimulus in conditioned suppression design in rats
OZONE—use as warning stimulus in conditioned suppression design in rats
PIGEONS—radiation detection by, conditioning for x
INSECTS—stimulation of visual system in Heliothis zea corn earworm (H.G.D.)

28594 (ORO-2903-33) A STUDY OF THE USES OF IONIZING RADIATION AS STIMULI. Comprehensive Report, September 1961–May 1967. Smith, James C. (Florida State Univ.,

Tallahassee, Dept. of Psychology). May 31, 1967. Contract AT(40-1)-2903. 18p. Dep. CFSTI.

Progress is reported on studies on the immediate response of pigeons and rats to x ray stimulation. X radiation was used as the conditioned stimulus in classical conditioning experiments. Results are reported on attempts to develop the conditioned suppression technique for measuring sensory threshold in pigeons and rats. The animals were deprived of food and taught to peck a key, press a bar, or lick a tube for food. After the animals were responding at a smooth rate, a warning stimulus was presented for several seconds and terminated by a brief electrical shock. The animals were soon conditioned to suppress the warning stimulus. When x radiation was used as the warning stimulus, immediate sensory detection of x radiation was observed that appeared to be associated with olfactory discrimination. In other studies x radiation was used as a noxious stimulus and a systematic study was made of the temporal relation of the presentation of saccharin and x ray exposure of rats and the initiation of the subsequent preference test. Preliminary results are included from studies on the effects of x radiation on the behavior of the noctuidae moth. A list of 31 is included of 31 publications during the period covered by this report. (C.H.)

28595 (UCLA-12-634) MORTALITY RATES IN IRRADIATED RODENT POPULATIONS. French, N. R.; Maza, B. G.; Kaaz, H. W. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). May 1967. Contract AT(04-1)-Gen-12. 23p. (CONF-670503-4). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Survival curves were computed for the pocket mouse (Perognathus formosus) populations of three fenced 20 acre plots. The animals of one plot were γ irradiated at a rate of approximately 1 R/day. The data are suggestive of radiation induced life shortening, but are not conclusive. Survival curves for irradiated (1 R/day) and control laboratory mice showed significant differences between the two groups and between the sexes in each group. Extrapolation of comparable radiation induced life shortening to survival rates of field populations of the same species indicated the importance of chronic radiation exposure from widespread radioactive contamination in a natural situation. The magnitude of the effect was related to the natural life spans in the field, and varied with the environment. A relatively long-lived species may suffer from such exposure, while a naturally short-lived species will be unaffected. There was no indication of increased survival rates of the wild species under chronic low level exposure, as has been indicated in similarly exposed laboratory rats and mice. (auth)

28596 (UR-669) EFFECTS ON MICE OF CONTINUAL EXPOSURE TO RADON AND ITS DECAY PRODUCTS ON DUST. Morken, Donald A.; Scott, James K. (Rochester Univ., N. Y. Atomic Energy Project). Oct. 1, 1966. Contract W-7401-eng-49. 135p. Dep. CFSTI.

Mice of the CAF-1 strain were exposed continually by inhalation throughout life to an atmosphere of radon and its disintegration products, in which the radioactivity content was about 14,000 times the maximum amount recommended for human occupational exposure. The short lived products of radon were attached to particles of a natural aerosol. The radon concentration was 0.42 μCi/l, the concentrations of RaA, RaB, and RaC-C' on dust were 0.34, 0.20, and 0.10 μCi/l, respectively. Mortality, body weight, hematological, and histological data were collected. In addition, mice exposed for 24 hours were used to provide information on the distribution of radioactivity within the body; dose estimates were made from these distribution data. The average dose rates from alpha activity were: whole body, 5.5 rad per week; lung-trachea-bronchi, 280 rad per week; kidney 18 rad per week; liver, 2 rad per week; gastrointestinal tract, stomach and contents, 60 rad per week. The radioactivity distribution measurements, in addition to allowing the estimation of doses to organs, suggested that deposition in the lung of inhaled radioactivity on dust amounted to nearly 100%, and that much of the deposited radioactivity was cleared from the respiratory tract with a physiological half time of about 10 minutes. A substantial portion of the cleared material was found in the gastrointestinal tract but a sufficient amount was found in the systemic system to suggest that dust-borne activity had rapidly dissolved from the dust particles and entered the blood. From a review of other experiments, it is concluded that a rapid clearance phase, with half time of 30 minutes, operates on much of any dust deposited in the lung. The median life span during exposure was 35 weeks, compared to 90 weeks for control mice. Histological studies on mice exposed past 35 weeks showed severe injury to the lung, but no injury elsewhere. The lung injury, principally in the trachea and bronchi, involved lesions characterized as destructive, hyperplastic and metaplastic; no carcinoma was evident. The accumulated lung dose at 35 weeks amounted to 10,000 rad. The accumulated whole body dose at 35 weeks, 200 rad, was sufficient in itself to provide the life shortening found, but with lack of histological findings, it must be concluded that death was due to lung injury. Body weight did not change during exposure, whereas control mice gained steadily in weight. Thus, growth was arrested by a process which affected the entire animal since miniaturization rather than emaciation resulted. By the 35th week the weights of exposed mice were about 70% of the weights of control mice of the same age. Hematological effects, evidenced by changes in the cellular composition of the blood, were similar to those reported for external irradiation applied continually. A mild anemia with accompanying reticulocytosis was found. Platelet counts were reduced soon after exposure, but returned to normal thereafter, and remained at normal levels despite the continuing irradiation. Neutrophil counts were increased during exposure whereas lymphocyte counts decreased steadily during the course of the exposure. A comprehensive survey of pertinent literature relating to radon inhalation as well as to external irradiations is included and discussed. Analytical methods are detailed for the prediction of radioactivity levels in the chamber and in the lung; included, also, are analytical methods for the rectification of counting data into the component disintegration products of radon, and the determination of counting efficiencies for radium-B and radium-C. (auth)

28597 (USNRDL-TR-67-35) ALTERED RECUPERATIVE POTENTIAL IN PREVIOUSLY IRRADIATED MICE. Ainsworth, E. J.; Larsen, R. M. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 3, 1967. 25p.

Earlier studies showed a non-recuperable component of radiation injury in rodents. This component is manifested by a small increase in radiosensitivity and an incomplete recovery of the hematopoietic system. The present studies were designed to evaluate the influence of previous sublethal irradiation, and perhaps non-recuperable lesions, on the ability of LAF_1 male mice to recuperate from x radiation injury. Recuperation from radiation injury was studied using the split-dose method. Mice were given an initial exposure to 450 R of x radiation from which they were allowed to recuperate. At 14 or 30 days after the initial exposure, the LD_{50}'s of the animals had returned to normal. When recuperation potential was measured at 14 days following the initial exposure, a significant delay in recuperation was observed. Thus, the return to a normal LD_{50} does not predict complete restoration of recuperative capacity. The delay in recuperation observed at 14 days was not present at 30 days after the initial exposure. This indicates that the radiation lesion that influences recuperation is not a persistent lesion. These findings have bearing on the concept of equivalent residual dose (ERD) that is used to predict radiation lethally in multiple exposure situations involving humans. (auth)

28598 (USNRDL-TR-67-37) RADIATION INDUCTION OF SKIN NEOPLASMS IN THE MALE RAT. Jones, Dave C.; Castanera, Toribio J.; Kimeldorf, Donald J.; Rosen, V. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 4, 1967. 37p.

Young adult male rats were irradiated with 430 or 680 rads of 250 kVp x rays or with 230 or 320 rads of fast neutrons, and examined at frequent intervals throughout life for the presence of skin (cutaneous or subcutaneous) tumors. Growths were surgically removed and histologically identified. There were 370 primary tumors and 3 metastases found among the 438 animals examined. At least half of the animals in each of the four irradiated groups developed skin tumors, as compared with about a fifth of their nonirradiated littermate controls. Significantly more irradiated animals had more than one skin tumor. The median age at initial appearance of tumors was significantly less in irradiated animals, particularly when the tumors were benign. On an age-specific basis, excess incidences of animals with tumors in the irradiated groups were apparent within about 8 months of exposure, and the effect was especially related to the occurrence of malignant tumors of epithelial origin. Tumors were found in irradiated animals in areas of the skin in which they were absent in the controls. In both irradiated and control animals, tumors developed with no evidence of previous gross destruction and regeneration of skin tissues. No consistent relationships between the incidence of animals with tumors and the dose or type of radiation were apparent. (auth)

28599 POSSIBILITIES OF UTILIZATION OF ULTRAVIOLET RADIATION AS A REACTION FACTOR OF LUMINESCENT CYTOCHEMISTRY OF LIPIDS. Kiliovska, M.; Tchakarov, E.; Popov, D. (Institut Superieur Medical, Varna, Bulgaria. Institut Superieur de Medecine Veterinaire, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 133-6(1967). (In French).

Skin sections of human embryos were fixed and treated with a

freshly prepared solution of acenaphthylene. The preparations were exposed to ultraviolet radiation. The following reaction was observed in the preparations treated with acenaphthylene. The lipid drops in the skin section have at the beginning a golden yellow luminescence, very intense which is accentuated after 30 to 60 sec and passes toward a brilliant whitish ring. On the dense non-actinic background there are many fine lipid droplets which correspond to mitochondria by their form, rate, and distribution. In the epithelial cells of the interlobular biliary canals lipid droplets are observed at the level of the Golgi zone. When the large lipid droplets are irradiated, the formation of large stellar, needle, or ramified crystals of acenaphenoquinone are observed. These have an almost white very intense luminescence corresponding to that which the crystals have after ultraviolet irradiation of acenaphthylene. These results show the possibility of using exciting radiation as a factor provoking a chemical reorganization of some luminescent and hydrophobic lipid substances. The fact that acenaphthylene makes it possible to show this very smallest lipid inclusion leads to its being proposed as a fluorochrome in the cases where the application of a very sensitive method is necessary. (J.S.R.)

28600 TREATMENT OF POLYCYTHEMIA VERA. Wasserman, Louis R.; Gilbert, Harriet S. (Mt. Sinai Hospital, New York). Med. Clin. N. Amer., 50: 1501-18(Nov. 1966).

Use of ^{32}P to treat this disease is described, and an assessment is made of its role in causing leukemia. Considerable debate has arisen as to whether the transition of polycythemia vera into a phase indistinguishable from acute blastic leukemia that occurs in 10 to 15% of patients is a complication inherent in the nature of the disease or whether it arises as a result of the type of therapy used. Various forms of irradiation have been found useful in controlling cellular proliferation, and most patients with the disease have been treated with either whole-body irradiation, x ray to the long bones, x ray to the spleen, or radiophosphorus and other isotopes. Retrospective analyses comparing the incidence of acute leukemia in patients with polycythemia vera treated with and without radiation suggest a strong relation between the occurrence of a terminal acute leukemia and prior irradiation. However, caution must be exercised in the interpretation of these findings because of lack of uniformity in the criteria used to diagnose polycythemia vera and acute leukemia as well as the preselection of cases that has led to the inclusion of the cases most difficult to control in the irradiated group. To clarify this question, a control group is required that consists of patients with polycythemia vera of the same degree of activity and clinical status as those treated with radiation; the controls are kept alive for a comparable period of time by treatment with nonradioactive modalities. Such a group is being collected by the authors. Gravity of the complications occurring in untreated patients and the lack of other equally effective forms of therapy made ^{32}P the treatment of choice in the past. In view of the successful use of alkylating agents in the control of the disease, the longevity of patients with well-treated polycythemia vera, and the need for repeated treatment to control proliferation over the years, chemotherapy would appear preferable. Alkylating agents are being used exclusively in the author's clinic except in elderly patients who are unavailable for frequent follow-up examinations or in those who have required infrequent ^{32}P treatment in the past for successful control of their disease. (BBB)

28601 NONUNION OF PATHOLOGIC FRACTURE AFTER RADIATION THERAPY. Bonarigo, Ben C.; Rubin, Philip (Strong Memorial Hospital, Rochester, N. Y.). Radiology, 88: 889-98 (May 1967).

A review of clinical material shows that irradiation of a pathologic fracture results in a nonunion. There is a disparity in healing of irradiated lytic metastases and pathologic fracture, which is the result of the retarding effect of radiation on chondrogenesis. This pathway is not of primary importance in the healing of bone lysis. Histologically, it is shown that both tumor and radiation have a detrimental effect on callus formation. Surgical pinning is a method of substituting a mechanical support for abolished callus. A method for treatment of pathologic fracture and imminent fracture is presented. (auth)

28602 INFLUENCE OF ANABOLIC SUBSTANCES ON THE ROTEIN SYNTHESIS IN ENDOCRINE ORGANS AND SOME OTHER INDICES OF PROTEIN METABOLISM IN IRRADIATED ANIMALS. Molotkov, O. V.; Grodzenskii, D. E. (Inst. of Medical Radiology, Moscow). Med. Radiol., 12: No. 4, 48-52(Apr. 1967). (In Russian).

Under investigation was the influence of the somatotrophic hormone and 19-nor-D-homotestosterone on the protein synthesis in endocrine and some other internal organs, weight of the organs and urinary excretion of nitrogen products in rats irradiated with 800 RAD were studied. The somatotrophic hormone reduces the drop in body weight, relative weight of the thyroid, pancreas, testes, thymus, liver, spleen and increases the weight of the adrenals in irradiated animals. After its administration there occurs a reduction in the excretion of total nitrogen on the first and third day, and of amino nitrogen on the first, third and fifth day after irradiation. On the fifth day after irradiation the somatotrophic hormone helps to normalize the protein synthesis in the hypophysis, pancreas, testes, thymus, liver and increases it in the spleen. Administration of 19-nor-D-homotestosterone in the irradiated animals inhibits somewhat the drop of the body weight, relative weight of the hypophysis, liver, spleen and even more increases the weight of the adrenals and reduces the weight of the thymus. In comparison with control rats it decreases the excretion of total and amino nitrogen on the first, third and fifth post-irradiation days. Its influence on the fifth day normalizes the synthesis of protein in the adrenals, liver, spleen and accelerates the synthesis in the kidneys. (tr-auth)

28603 RESPONSE OF X-IRRADIATED LIMBS OF ADULT URODELES TO AUTOGRAFTS OF NORMAL CARTILAGE. Eggert, Ronald C. (Cornell Univ., New York). J. Exp. Zool., 161: 369-89(Apr. 1966).

The left forelimbs of 100 adult newts (Triturus viridescens) were exposed to 1560 or 2000 R of localized x irradiation; right and left forelimbs were amputated through the distal humerus. Eighty of the left irradiated forelimbs were then implanted autoplastically with cartilage taken from the dorsal cartilaginous plate of the unirradiated contralateral scapula and rendered virtually free of all cell types other than chondrocytes by manual stripping of soft tissues and perichondrium (60 cases) and manual stripping combined with brief alcohol immersion (20 cases). The results showed that the unirradiated right forelimbs regenerated normally in all cases They also showed that the irradiated left control limbs (no implants) failed to regenerate in all cases (20). In contrast, those irradiated limbs implanted with unirradiated cartilage developed blastemas which differentiated into irregular masses of cartilage. No blastemas developed following differentiation of irradiated stump tissues. The blastema developed concomitantly with the breakdown of the implanted cartilage. Since these two events were separated by a time interval of two weeks, it is concluded that the blastema was formed by a direct, massive contribution of cells from the normal autograft. Further, the histologic evidence presented indicates that most, if not all, of the blastema cells derived from chondrocytes of scapular origin in adult newts and implanted autoplastically into irradiated limb tissue differentiated into chondrocytes. (BBB)

28604 INFLUENCE OF CHRONIC ACCELERATION ON THE EFFECTS OF WHOLE-BODY IRRADIATION IN RATS. Casey, Harold W.; Cordy, Donald R.; Goldman, Marvin; Smith, Arthur H. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Tex.). Aerospace Med., 38: 451-7(May 1967).

Studies of the combined effects of chronic acceleration and acute ^{60}Co whole-body irradiation were performed on rats. Rats exposed to accelerative forces (2.0 to 3.0 g), produced by continuous centrifugation, were observed for periods up to four months. Deleterious effects were not produced by acceleration per se, as physiologic adaptation was evident by the seventh to fourteenth day. On gross and histologic examinations a depletion of body fat deposits and a reduction in body mass were the only detectable differences in accelerated rats when compared with control rats. Continuous acceleration, immediately following irradiation, increased radiation mortality and the mortality increased progressively with increases in the accelerative force. Prior adaptation of rats to acceleration had no influence on the increased mortality. Deceleration to normal gravity followed by irradiation had no effect on mortality. In accelerated-irradiated rats that died, the lesions found by gross and histologic examinations were typical of those produced by radiation. Accelerated rats sacrificed 30 days following irradiation had lesions comparable to non-accelerated irradiated rats that indicated that the pathologic changes produced by irradiation were not altered by acceleration. The results showed that the biologic response to whole-body irradiation was altered by changing the weight to mass ratio with accelerative forces above normal gravity. The exact cause of the increased mortality was not determined. (auth)

28605 SOME COMPARATIVE ELECTRON MICROSCOPE, HISTOPATHOLOGIC, HISTOCHEMICAL STUDIES OF THE CENTRAL NERVOUS SYSTEM OF RATS FOLLOWING X-IRRADIATION. Roizin, L.; Rugh, R.; Kaufman, M.; Ores, R. (Psychiatric Inst., New York). pp 95-9 of Proc. 4th Intern. Congr. Neuropathol. Sept. 4 to 8, 1961, Munich. Vol. 2. Stuttgart, Georg Thieme Verlag, 1962.

Comparative histologic, histochemical, and electron microscope studies were used to investigate possible histopathogenic mechanisms in the central nervous system following intrauterine x irradiation. Exencephaly was induced by intrauterine irradiation of

rat embryos at 8.5 days of gestation with 150 R. The fetuses were removed by laparotomy one day before expected delivery. Most rats irradiated in utero presented various degrees of exencephaly (herniation of the brain through defective vault of the skull). The exencephalic portion of the central nervous system of the irradiated animals showed striking microscopic abnormalities which also varied also from animal to animal. Cytoarchitecture was markedly disturbed with partial preservation of segments of layers or circumscribed areas surrounded by tissue of abnormal cellular arrangement. In others the entire cerebral tissue lacked cellular organization into definite structural patterns or systems. Isolated or groups of neurons appeared scattered at random within necrotic amorphous material containing macrophages. Electron microscopy revealed many structural changes in the cellular elements of central nervous tissue. Cytoplasm of neurons and phagocytes contained large or small osmiophilic structures which varied in size, shape, and distribution. Nuclear double membranes often showed enlargements, infoldings, or blebs. Mitochondria displayed marked pleomorphism and variations in distribution. Enlargement of the cysternae of the ergastoplasm as well as presence of a large number of enlarged or extended Golgi canaliculi were noted. Variations occurred in concentration and distribution of RNA granules, and small lysosome-like vesicles appeared. (BBB)

28606 MORPHOLOGIC CHANGES IN THE BRAINS OF RATS IRRADIATED WITH DIFFERENT DOSES OF GAMMA RAYS. **Ojak, Maria; Maruchin, Adam (Zaklad Patologii Doswiadczalnej, Warsaw). Patol. Pol., 17: 163-70(Apr.-June 1966). (In Polish).**

Histopathologic studies were conducted on various regions of the brain of Wistar rats irradiated with ^{60}Co γ rays at a dose rate of 26 R/min for 100, 200, 400, 600, and 800 R. The rats were killed by decapitation after 30 days, and the brains were stained by the Heidenhain-Woelcke, Bodian, Hortega, and hematoxylin-eosin techniques. After doses of 100 to 200 R, slight vascular lesions were observed, indicating increased permeability of the blood vessel walls. After doses of 600 to 800 R the changes were more pronounced, assuming the character of changes typical of cerebral edema. An attempt was made to correlate the late effects of irradiation with vascular changes. The ischemic effects may be attributed to primary blood vessel injury with secondary effects on neural cells. (BBB)

28607 THE EFFECTS OF X-RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. I. THE EARLY RESPONSES. **Fox, D. P. (Marischal Coll., Aberdeen, Scotland). Chromosoma, 19: 300-16(1966).**

Cytogenetic studies were conducted on incubated locust eggs x irradiated with 25 to 400 R doses. Irradiation of embryo cells of Schistocerca gregaria in the 2 hr before mitotic anaphase produced a characteristic series of responses of chromosomes. An apparently insensitive stage was followed by the production of stickiness and side-arm bridges and finally by mitotic delay. Mitotic delay was complete at doses as low as 25 R. Both interstitial and terminal stickiness was observed and could be consistently distinguished from side-arm bridges. These 2 phenomena showed different appearance kinetics. Cells showing stickiness reached anaphase 10 min after irradiation, i.e., 20 min before the appearance of side-arm bridges. It is argued that stickiness is due to a generalized physiological process and that side-arm bridges are due to a localized exchange of discrete sub-units of the chromatid. These conclusions are based upon the kinetics of appearance and dose-response and a comparison of haploid and diploid cells in a haplo-diploid mosaic embryo. (BBB)

28608 STATE OF THE PERIPHERAL BLOOD AND BONE MARROW IN PATIENTS SUFFERING FROM DIFFUSE TOXIC GOITER DURING RADIOIODINE THERAPY. **Dozorets, Yu. L.; Perlin, M. S.; Popova, L. I.; Eidel, I. I. Med. Radiol., 12: No. 4, 41-4(Apr. 1967). (In Russian).**

An analysis of the state of hematopoietic organs in 540 patients suffering from thyrotoxicosis treated with radioiodine was conducted. Before treatment the patients manifested anemia, leukopenia, relative lymphocytosis, thrombocytopenia, accelerated erythrocyte sedimentation rate. The more severe the form of thyrotoxicosis the more significant were changes in the blood. Anemia and leukopenia are explained by inhibition of maturation of red and white cells of the bone marrow. In most patients the ratio between the leuko- and erythrocytic series was above normal, the number of lymphocytes in the bone marrow was augmented. An inhibition of thrombopoiesis and an increased quantity of plasmatic and reticular cells were noted. At remote periods after radioiodine treatment it was observed that along with disappearance of signs of thyrotoxicosis there occurs a normalization of the peripheral blood; the maturation of red cells also improved. Cells of the neutrophilic series manifest a tendency towards maturation. The number of lymphocytes drops, but still exceeds normal values. The quantity of plasmatic and reticular cells normalizes. The greater the time lapse after successful ^{131}I radioiodine therapy the more marked is the normalization of the peripheral blood and bone marrow. (tr-auth)

28609 CONTENT OF SIALIC ACIDS IN THE BLOOD OF THYROTOXICOSIS PATIENTS TREATED WITH RADIOIODINE. **Udod, V. M.; Kuz'mak, N. I. Med. Radiol., 12: No. 4, 45-8 (Apr. 1967). (In Russian).**

The content of sialic acids in the blood was determined in 35 thyrotoxicosis patients treated with radioiodine; follow-up studies ranged from 3 months to 7 years. Parallel investigations were made of the basal metabolism and radioindication of the thyroid gland. There was noted a direct relation between the content of sialic acids and the severity of thyrotoxicosis. With abatement of the disease under the influence of radiation treatment the content of sialic acids drops in the blood. Recovery is attended by their normal content. The dose of radioiodine used for the treatment exerted no noticeable influence on the content of sialic acids in the blood. The determination of the level of sialic acids in the blood is recommended as control of the results of radiotherapy of thyrotoxicosis. (auth)

28610 ELECTRON MICROSCOPIC CHANGES IN THE THYROID GLAND IN LOCAL IRRADIATION. **Kharlampovich, S. I.; Gulyaev, V. A. (Inst. of Medical Radiology, Moscow). Med. Radiol., 12: No. 4, 33-6(Apr. 1967). (In Russian).**

An electron microscopic study of locally irradiated (930 RAD) thyroid gland of male rats of the August line was conducted parallel with biological testing of the gland on larvae of Rana temporaria. Changes in the ultrastructure and biological activity give grounds to suppose that during the first week after irradiation there occurs an impairment in the processes of thyroglobulin synthesis, colloid resorption and hormone formation in the thyroid gland. The balance between these processes restores 2 to 4 weeks after irradiation. The more radiosensitive cells of the follicular epithelium undergo complete destruction during the first 1 to 3 days. (auth)

28611 A FOLLOW-UP STUDY OF A GROUP OF PATIENTS WHO RECEIVED THORIUM DIOXIDE FOR CEREBRAL ARTERIOGRAPHY. **Janower, Murray L.; Sidel, Victor W.; Flynn, M. Jean (Massachusetts General Hospital, Boston). Contract PH86-65-134. Radiology, 88: 1004-6(May 1967).**

The importance of the Thorotrast patient as a source of information on the effects of low-dose, chronic, internal-emitter irradiation and background material relating to Thorotrast is presented. One hundred and fifty-three patients who received Thorotrast at the Massachusetts General Hospital have been traced and are evaluated in part. Ninety-two have died of causes not presently known to be related to radiation. Sixty-one patients are living in fair-to-good general health. Three tumors have developed, but none of a type presently known to be radiation-related. Other studies have suggested that the mean latent period for tumor induction is nineteen years. This period has lapsed for only a few of our patients, and continued follow-up is indicated. (auth)

28612 EFFECT OF IRRADIATION OF BRAIN TUMOURS ON VENTRICULAR FLUID PRESSURE. **Hakansson, C. H. (Lund Univ. Hospital, Sweden). Acta Radiol., Therapy, Phys., Biol., 6: 22-32(Feb. 1967).**

Three cases of cerebral tumors, x irradiated with a daily dose of 200 to 400 R are reported. Continuous recording of the intracranial pressure before and during the first few days of treatment revealed no definite increase ascribable to the irradiation, and no change found in the total protein content of the ventricular fluid. (auth)

28613 INFLUENCE OF GESTATION AND LACTATION ON RADIOSTRONTIUM-INDUCED MALIGNANCIES IN MICE. I. INCIDENCE, DISTRIBUTION, AND CHARACTERISTICS OF ^{90}Sr-INDUCED MALIGNANCIES. **Nilsson, A. (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol., Therapy, Phys., Biol., 6: 33-52(Feb. 1967).**

It was clearly shown from a study of the influence of gestation and lactation on the carcinogenesis of ^{90}Sr in female mice that this brings about a significant increase in the latency period of bone sarcoma and a similarly significant reduction in the total number of skeletal tumors as compared with the unmated control group. A distinct influence on tumor location was also revealed, with lower tumor frequency in the lumbar and sacral vertebrae and pelvic bones. Damage to the blood and blood-forming organs was reduced in the gestating and lactating groups of mice. On the other hand, the frequency of leukemia increased, and to a certain degree also the frequency of tumors in soft tissues. (auth)

28614 EFFECT ON FERTILITY OF CONTINUOUS GAMMA-IRRADIATION DURING THE SUCKLING PERIOD IN MICE. **Roennbaeck, C. (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol., Therapy, Phys., Biol., 6: 53-60 (Feb. 1967).**

Female mice were irradiated with γ rays at low dose rates from a ^{137}Cs source during different periods of their first weeks of life. The administration of 100 R during the second week made the females sterile. Additional experiment with lower doses carried out during this sensitive period suggested a linear relationship between dose and fertility. (auth)

28615 EXPERIMENTAL STUDY OF THE REACTION OF THE SKIN TO THE COMBINED EFFECT OF X-RAY IRRADIATION AND CHRYSOMALLIN. Letov, V. N. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 12: No. 4, 11-15(Apr. 1967). (In Russian).

An experimental study on the reaction of skin to the combined effects of x radiation and chrysomallin was undertaken. The skin of the hind leg of mice was exposed to multiple doses of 900 and 3,600 R and single doses of 1,000, 2,000, and 3,000 R. It was observed that x radiation inhibited the growth of hair on the exposed limb. Also it was concluded that the inhibition of hair growth was intensified when chrysomallin was administered 4 to 24 hr after irradiation. Chrysomallin had no effect if administered before 4 hr after x irradiation. With high doses of x radiation the combined action doubles this effect. (S.M.H.)

28616 INFLUENCE OF COMBINED ACTION OF X-RAY IRRADIATION AND CHRYSOMALLIN ON MYELOPOIESIS. Potanov, S. L. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 12: No. 4, 16-19(Apr. 1967). (In Russian).

In experiments on mice $(C_{57}Bl \times CBA)F_1$, after a single combined action of irradiation and chrysomallin the quantity of nucleus-containing cells and the absolute number of cells of each type in the femoral bone were counted. The combined use of chrysomallin and irradiation induced reduction in the number of myeloid cells after the separate action of each of these agents; this decline could be characterized as an imcomplete summation of effects. After the combined use of two agents there was noted the greatest decrease in the number of lymphocytes and cells of the erythroblastic series; among those affected were immature forms (proerythroblasts and basophilic erythroblasts). During fluorescence microscopy of the bone marrow at early periods after the combined action no summation of effects was observed. (auth)

28617 LUNG CARCINOMAS IN IRRADIATED PARABIOTIC RATS. Goldenberg, Victor E. (Univ. of Washington, Seattle); Chute, Rosanna N.; Warren, Shields. Contract AT(30-1)-901. J. Thorac. Cardiov. Surg., 53: 441-7(Mar. 1967).

Parabiotic animals offer a unique opportunity to study carcinogenesis as produced by supralethal whole-body irradiation of one partner while the other is shielded. This experiment comprised 350 female and 250 male irradiated parabiotic pairs. As nonirradiated controls, 217 pairs were used, in addition to 443 single, nonirradiated controls. Young littermate Deaconess–Slonaker rats of the same sex were joined in parabiosis following a modified Bunster–Meyer technique. After parabiosis was well established, the right-hand rat was given a supralethal total-body dose of 1000-R by 250-KV x rays. Except for occasional antibiotic therapy (penicillin and tetracycline in drinking water), the animals were given no further treatment. Most animals of both the experimental and control groups were maintained until death occurred. Eight primary pulmonary carcinomas were found in 600 parabiotic pairs of rats after one partner had received whole-body irradiation. Five tumors occurred in irradiated and 3 in nonirradiated partners. The incidence of carcinomas, however small, was considered significant. Irradiation carcinogenesis was implicated in the former, while the cause of the latter remains obscure. Pulmonary carcinomas were not found in 877 nonirradiated single or parabiotic control rats. No hormonal or viral alterations were implicated. (BBB)

28618 ENHANCEMENT OF DINITROCHLOROBENZENE (DNCB) CONTACT SENSITIZATION BY CYCLOPHOSPHAMIDE IN THE GUINEA PIG. Maguire, Henry C. Jr. (Rockefeller Univ., New York); Ettore, Von L. J. Invest. Dermatol., 48: 39-43(Jan. 1967).

The action of cyclophosphamide (a nitrogen mustard) on immunologic responses in the guinea pig was compared with that of x rays. Generally, whole-body x radiation and such cancer chemotherapeutic drugs suppress primary antibody formation and the acquisition of delayed hypersensitivity. Guinea pigs received a 5-day course of cyclophosphamide, and on day 5 were topically sensitized to dinitrochlorobenzene (DNCB). The DNCB challenge reactions of these guinea pigs were exaggerated and prolonged. This represented a paradoxical effect, since cyclophosphamide is a well-established immunological inhibitor in the guinea pig. It is likely that whole-body irradiation as well as other of the immunosuppressive cancer chemotherapeutic drugs can be so manipulated as to enhance the acquisition of allergic contact dermatitis. Thus it is possible to so time antigen injection as to enhance primary antibody formation with whole-body irradiation. The time relation between antigen and x-ray is crucial and unique for each antigen. For instance, with soluble bovine γ-globulin as antigen in rabbits, x irradiation 2 hr after antigen did not affect antibody formation, whereas there was considerable enhancement if given 1, 2, or 2½ days after antigen. The rapid and seemingly complete restoration of lymphoid tissue after near-complete destruction by cyclophosphamide or irradiation is impressive and implies a sensitive and dynamic homeostasis of lymphoid tissue. These regulatory mechanisms may direct the immunological performance of lymphoid tissue. On this basis, diverse treatments having the common result of depression followed by regeneration of lymphoid tissue could enhance the hypersensitivity response. Such potential immunological adjuvants would include heterologous antilymphocyte sera, glucosteroids, and certain viruses, as well as whole-body irradiation and many of the cancer chemotherapeutic drugs. (BBB)

28619 EFFECT OF ADRENAL HORMONES, METHYLCHOLANTHRENE, AND IONIZING IRRADIATION UPON AMINOAZO DYE N-DEMETHYLATING ACTIVITY IN REGENERATING RAT LIVER. Terayama, Hiroshi; Takata, Ayako (Tokyo Univ.). J. Biochem. (Tokyo), 60: 1-11(July 1966).

Whole-body irradiation (400 to 880 R) of rats with ^{60}Co γ rays did not affect either the aminoazo dye N-demethylating activity or the hydroxylating activity of rat liver. It also had no significant effect on the induction of the enzymatic activities by methylcholanthrene. Irradiation, however, appeared to increase the reduction of enzymatic activity following partial hepatectomy. The course of the N-demethylating activity of regenerating rat liver after partial hepatectomy or a sham operation (laporatomy) was studied. In both cases, a marked reduction (50%) in enzymatic activity was observed within a few hours after the operation. After sham operation, the activity returned to the normal level within one day. After partial hepatectomy, however, the activity remained at a low level for 24 hr and then gradually returned to the normal level over a period of four days, in parallel with liver regeneration. Administration of cortisone had no effect on the N-demethylating activity of normal liver but partially prevented the decrease in enzymatic activity caused by adrenalin injections or partial hepatectomy. Administration of adrenalin caused a large and rapid decrease in N-demethylating activity. This was also observed in methylcholanthrene-treated rats. Methylcholanthrene induced N-demethylating activity in partially hepatectomized rats. A large prior dose of methylcholanthrene appeared to prevent reduction in the enzymatic activity after partial hepatectomy. (BBB)

28620 ACROMEGALY PRE- AND POSTPITUITARY IRRADIATION. Kozak, George P.; Vagnucci, Anthony I.; Lauler, David P.; Thorn, George W. (Peter Bent Brigham Hospital, Boston). Metab., Clin. Exp., 15: 290-303(Apr. 1966).

Various endocrine and metabolic effects of x irradiation of the pituitary were followed in 7 acromegalic patients. Complications, clinical results, and metabolic effects of megavoltage x rays are considered as compared with those obtained with proton beams and ^{90}Y implantation. (TSS)

28621 PENETRATION OF EPIDERMIS BY ULTRAVIOLET RAYS. Everett, Mark Allen; Yeargers, Edward; Sayre, Robert M.; Olson, Robert L. (Univ. of Oklahoma, Oklahoma City). Photochem. Photobiol., 5: 533-42(July 1966).

Previous studies have indicated that virtually none of the incident uv radiation shorter than 320 mμ passes through human epidermis to reach the dermis. As a result, both the erythema reaction to uv radiation and solar carcinogenesis have been considered to result from primary epidermal events. However, the present data suggest that, in caucasians, a physiologically significant proportion of incident uv radiation may penetrate to the corium and capillary blood vessels. The penetrating quantity varies according to wavelength from as little as 1% at 250 mμ up to 44% at 320 mμ. This is of considerable significance since at 300 mμ an average minimum erythema dose (MED) is 10^{16} photons/cm^2. The appreciable amount of at least 10^{15} photons/cm^2 would thus penetrate to the dermis. These data show that both the erythema mechanism and cutaneous carcinogenesis may not necessarily be primary epidermal events. Other phenomena suggest that there are pronounced dermal effects produced by uv radiation which may be directly rather than indirectly initiated. Further evidence that physiologically significant quantities of uv transverse the epidermis was provided by in vivo experiments. When calculated MED's were administered through the epidermal specimens to human abdominal skin, erythema was produced as predicted, demonstrating the physiological importance of transepidermal radiation. (BBB)

28622 THE IMPORTANCE OF VIRUS DISEASES, RADIATIONS, AND DRUGS DURING PREGNANCY IN THE ETIOLOGY OF CONGENITAL ENCEPHALOPATHIES. Copelman, Louis S. Ann. Medicopsychol. (Paris), 121: 537-48(Apr. 1963). (In French).

A review is presented of the teratogenic effects of ionizing radiations, and other physical and chemical agents, on the brain of

mammals. Malformations which have been observed in the offspring in women receiving therapeutic irradiation during pregnancy are described. The ocular anomalies include microphthalmia, coloboma, cataract, nystagmus, chorioretinitis, and strabismus. The cerebrocranial defects include anencephalia, microcephalia, encephalocele, hydrocephalus, and cerebral atrophy. Skeletal disorders have been noted, such as spina bifida, auricular malformations, and palatine fissures. The differential radiosensitivity of organogenesis at various gestational stages of the fetus is discussed. For the human embryo, greatest sensitivity occurs from the 2nd to 6th week, and evidence indicates that fetuses up to 6 months old may be sensitive to as little as 2 to 5 R. In light of these findings, precautions to be used in diagnostic radiology in pregnant women are examined. The genetically significant dose is also considered. This dose, as applied to diagnostic x rays, may be 17 to 160% of the mean background dose from natural sources. (BBB)

28623 PITUITARY ADENOMA: RESULTS OF COMBINED SURGICAL AND RADIOTHERAPEUTIC TREATMENT OF 260 PATIENTS. Elkington, S. G. (St. Thomas's Hospital, London); McKissock, Wylie. Brit. Med. J., 1: 263-6(Feb. 4, 1967).

The results of treatment of 260 cases of pituitary adenoma by a combined surgical and radiotherapeutic technique are reviewed. All operations were performed through the transfrontal route, and all but 19 patients surviving for more than 6 weeks received irradiation subsequently. Effects and side-effects of irradiation are described. A course of radiotherapy was given as a routine in the early postoperative period, except in patients who had already received preoperative irradiation. The present technique employs a tumor dose of 3000 to 4000 R administered over 28 days, though in the past larger doses were occasionally used. The occurrence of radiation damage to the cerebral hemispheres was noted in some patients. During the early years of the series 10 patients were given radiotherapy in doses now recognized as carrying a risk of radiation damage to nervous tissue. Nine of these patients died between 10 months and 7 yr after completion of the course. Radiation damage was demonstrated by necropsy in 3 patients and appeared to be probable on clinical grounds in 2 more. The tenth patient survived for 22 yr but was disabled by lens opacities and by progressive dementia for much of this period. Treatment was particularly successful in relieving headache, but less so in improving lesions of the oculomotor and abducent nerves. Impairment of both olfaction and hearing was more common subsequently, the latter as a result of irradiation, while the rise in the incidence of epilepsy was from 2.3% to 4.7%. Hypothalamic injury, as shown by diabetes insipidus, occurred in 10 patients. (BBB)

28624 RADIATION NECROSIS AND REPAIR IN RAT FETAL CEREBRAL HEMISPHERE. D'Agostino, A. N.; Brizzee, K. R. (Univ. of Utah, Salt Lake City). Arch. Neurol., 15: 615-28 (Dec. 1966).

Pregnant female rats were exposed to whole-body x-irradiation on the 13th day of gestation. The fetuses were surgically removed at various time intervals after irradiation. The cerebral hemispheres were removed, sectioned, and prepared for electron and light microscopy. Photographs showing the effects of radiation on the brain tissue are presented. Radioinduced necrosis was manifested by pyknosis of the nucleus and cytoplasm. No cytological changes were observed up to 6 days that could be considered a late effect of irradiation. (H.L.W.)

28625 EFFECT OF X-IRRADIATION ON RAT THYMOCYTE NUCLEI. I. PHOSPHATE METABOLISM. Zimmerman, D. H.; Cromroy, H. L. (Univ. of Florida, Gainesville). Life Sci., 6: 621-7(Mar. 15, 1967).

It was previously reported that isolated thymus nuclei exhibited a unique phosphorylation mechanism at low temperature (5°C), and that this phosphorylation is sensitive to ionizing radiation. Research was initiated to repeat this earlier work under well-controlled conditions to assess the effect of x radiation on nuclear phosphorylation. It was found that irradiated thymocyte nuclei release orthophosphate, but the loss of ability to form acid–labile phosphate by nuclei following irradiation was not confirmed. Five- to 6-week-old SDD male weanling rats were used for the nuclear phosphorylation studies on isolated thymocyte nuclei after the in vivo irradiation of the thymus. One group received a total dose of 100 R in 1 min and another group received 200 R in 2 min. The animals were sacrificed 1 hr after irradiation and thymus nuclei were isolated. The rise in acid-labile P was not statistically significant at the 95% confidence level for the control vs 100-R irradiated nuclei, but the rise was statistically significant for the 200-R irradiation treatment vs control nuclei. Thus, these results are contrary to the earlier report of a 100% decrease in the capacity of nuclei irradiated with 100 R in vivo to form acid-labile P 1 hr after irradiation in vitro. (BBB)

28626 THE INFLUENCE OF WEAK RADON ACTION DURING THE EMBRYONIC PERIOD ON THE SERUM PROTEINS OF THE HEN. Schroecksnadel, H.; Wachter, H. (Univ., Innsbruck, Austria). Fund. Balneo-Bioclimatol., 3: 206-12 (Dec. 15, 1965). (In German).

Fertilized eggs from healthy hens were hatched in a brood chamber in normal atmospheric air or in Rn-containing air (5 nCi/l). The serum proteins were determined electrophoretically 3 days, 3, 6, and 12 months after the chickens hatched. In comparison to the chickens from eggs kept in normal air, the Rn-exposed chickens showed a tendency toward a decrease in albumin, α_2-, and β-globulins, and an increase in γ-globulin. Only the increase in γ-globulin with 3-day-old chickens ($p < 2\%$) and 3-month-old chickens ($p < 5\%$) was appreciable. There was no longer a difference, compared to normal hens, in the composition of serum proteins in the daughter generation of Rn-exposed hens, which were hatched in normal air from fertilized eggs of Rn-treated animals, except for a slight tendency toward an increase in globulins in 3-day-old chickens. (BBB)

28627 EFFECTS OF POSTRADIATION INDUCED ERYTHROPOIETIN ON BONE MARROW OF RATS EXPOSED TO DIFFERENT DOSES OF X-RAYS. Hajdukovic, S. (Univ., Liege); Szirmai, E. Haematologica (Pavia), 52: 41-56(1967).

Rats of the Wistar strain, weighing 180 to 200 g, were exposed to 100 to 600 R doses of x rays and immediately submitted to the severe bleeding. The reduction of total blood volume was 40 to 50%. A corresponding quantity of physiological saline was injected to counteract circulatory failure. At various periods after irradiation the animals were killed, smears of bone marrow were stained by the Giemsa technique, and the number of erythroid cells and myeloid/erythroid cell ratios were calculated. Another group was injected with colchicine and 4 hr later sacrificed to evaluate mitosis in bone marrow cells. After 100 R the number of mitoses in bone marrow decreased 50% and the normal value was restored on the 4th to 5th day. The depression was greater after 200 R and recovery took place on the 5th postradiation day. The number of bone marrow cells in mitosis was drastically decreased after the doses of 400 and 600 R, and recovery of the normal level occurred on the 6th postradiation day after 400 R but not by the 7th day in the 600-R group. By 24 hr after 100 R, mitosis increased, with tendency toward the maximal count on the 5th postradiation day. In animals exposed to 200 R and bled, after temporary decrease at 24 hr after irradiation, mitoses increased from the 3rd to the 7th day. The number of mitoses in irradiated-bled animals exceeded that in irradiated controls, and was higher than in nonirradiated-bled controls. The marked depression in the mitotic process in the animals exposed to 400 R and particularly after 600 R (up to the 6th day and/or 7th day after 400 and 600 R respectively) was only present in irradiated-bled animals during the first 3 to 4 days. From the 3rd day in the 400-R group, and the 4th day in the 600-R group, regenerative processes took place in the bone marrow, as demonstrated by an increased number of mitoses. After the doses of 400 and 600 R the number of erythroid cells was markedly increased in the animals bled after irradiation. This is in agreement with the results obtained on the stathmokinetic index, both tests indicating increased regenerative processes due to the post-irradiation bleeding. (BBB)

28628 OSTEOGENIC SARCOMA: A STUDY OF SIX HUNDRED CASES. Dahlin, David C.; Coventry, Mark B. (Mayo Clinic, Rochester, Minn.). J. Bone Joint Surg., 49A: 101-10 (Jan. 1967).

The development of osteogenic sarcoma in 16 out of 600 patients whose bones had been previously irradiated is reported. The sarcomas occurred at appropriately long intervals after irradiation. Three developed after irradiation for carcinoma of the breast; all 3 affected the scapula. Two followed irradiation for squamous cancer of the cervix and 1 followed irradiation for adenocarcinoma of the endometrium; 2 of these 3 involved the upper portion of a femur and 1 the ilium. Three of the postirradiation sarcomas occurred at sites of prior giant-cell tumor, 3 in indeterminate prior bone lesions, 2 in aneurysmal bone cysts, 1 in a focus of fibrous dysplasia, and 1 after irradiation for an overlying cutaneous birthmark. In addition to these 16 postirradiation osteogenic sarcomas, the Mayo Clinic files to January 1, 1965, contain 7 osteogenic sarcomas of the jawbones, 18 fibrosarcomas of various bones, 1 Ewing sarcoma, and 1 chondrosarcoma arising in bones that had been the site of prior irradiation. Although a direct cause-and-effect relation cannot be proved in any of these sarcomas, the circumstantial evidence overwhelmingly supports the view that one exists, and a more detailed review of all these 43 postirradiation sarcomas of bone is now in progress. (BBB)

28629 LATE INTESTINAL LESIONS OF THE PELVIC REGION FOLLOWING TREATMENT BY PHYSICAL AGENTS.

d'Huart, Francois. Bull. Soc. Sci. Med. Grand-Duche Luxembourg, 102: 363-6(Nov. 1965). (In French).

Four cases of radioinduced intestinal injury that required surgery are reported. In Case 1, a 12,600-R dose of radiation was given for ovarian cancer 6 yr previously. Partial intestinal stoppage developed and was treated by removal of stenosed ileal segments. The biopsied specimen showed telangiectasis of the mucosa and fibrosis of the submucosa, with interstitial edema and hyalination and narrowing of the blood vessels. In the 2nd case, ileal stenosis also occurred, within a year after 11,180-R irradiation of uterine cervical tumor. Ulceration was present in the specimen obtained when anastomosis was performed. Case 3 developed abdominal cramps 5 yr after an unknown dose of radiation was given for an epithelomatous lesion of the uterine cervix. This was accompanied by severe anemia. A stenosed segment of ileum was removed. In Case 4, sigmoiditis was noted 5 yr after a 13,000-R dose was given following a Wertheim hysterectomy. The diseased segment of the large intestine was removed. No evidence of malignancy was found in any of these cases. Apparently, when a dose of 10,000 R to the lower pelvis is given, late intestinal complications can occur. (BBB)

28630 EFFECTS OF X-RAYS ON RESPIRATION OF SARCOPHAGA PUPAE. Sato, C.; Sasaki, S. (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1180-3(Dec. 1966). (In Japanese).

Age-specific amount of oxygen consumption of pupal Sarcophaga makes a U-shape curve of respiration. The ascending part during latter half of pupal stage was inhibited by X-rays. When pupae were measured on the eighth day, inhibition of respiration responded differently with dose and age at which the dose was given. Within 24 hours after puparium formation, respiration was very sensitive to inhibitory effects of radiation but when irradiated on 4th day of pupal development, it was quite insensitive. Sensitive component of respiration decreased exponentially with age and mean effective dose of inhibition increased exponentially with age (0 to 4 days). During this period, fraction of isolated myoblasts in muscle tissue also decreased with age. Inhibition of respiration of one day old pupa was significantly related to decrease in protein of giant mitochondria of flight muscles. (NSA of Japan)

28631 A COMPARISON AND EVALUATION OF VARIOUS RADIATION HAZARDS IN METROPOLITAN AREAS. Morgan, K. Z. (Oak Ridge National Lab., Tenn.). pp 41-5 of Proceedings of the Second Symposium on Health Physics, Pecs, Hungary, September 26-30, 1966. Vol. II. Budapest, Publishing Group of the Central Research Institute for Physics, 1966.

See CONF-660948-(Vol.2).

Various sources of potential radiation exposure of man are examined and the contribution of each to the radiation burden of man is evaluated. It is concluded that exposure during diagnostic x-ray examinations is the most important contribution to the dose received by the population from man-made sources of ionizing radiation. (C.H.)

28632 NEOPLASMS IN PERSONS TREATED WITH X RAYS IN INFANCY FOR THYMIC ENLARGEMENT. A REPORT OF THE THIRD FOLLOW-UP SURVEY. Hempelmann, Louis H.; Pifer, James W.; Burke, George J.; Terry, Roger; Ames, Wendell R. (Univ. of Rochester, N. Y.). J. Nat. Cancer Inst., 38: 317-41(Mar. 1967).

In upstate New York, 2,878 persons given x-ray treatment in infancy for thymic enlargement and their 5,006 untreated siblings were surveyed by mail in 1963 for the third time to determine the current incidence of neoplasms and mortality. Questionnaires revealed that an excess number of tumors had developed in the treated population since last surveyed (1959). Thyroid neoplasms, including 5 carcinomas, accounted for 11 of the 26 new tumors. No new cases of leukemia or osteochondroma occurred after age 20. A definite dose response was established for both thyroid and "pooled" extrathyroid neoplasms. The incidence of thyroid neoplasms was much higher in persons treated with anterior and posterior (AP) x-ray ports than in those treated with anterior (A) ports only. Presumably, this was because AP treatment usually irradiated the gland with the primary x-ray beam, whereas A treatments usually exposed the gland to smaller doses of scattered x rays. The magnitude of the thyroid dose could not be correlated with the latent period between exposure and tumor development, or whether any given lesion was malignant or benign. The incidence curve for thyroid neoplasms rises sharply in the 10 to 19 year category, flattens in the 20 to 29 year category, and that for carcinomas may actually decline after age 20. Five of the six thyroid carcinomas occurring under age 15 were in males. All 19 persons with thyroid carcinomas, including 9 with metastases, responded well to therapy and were healthy at the time of the survey. Plans for future study of the high-risk and low-risk groups in the irradiated population are discussed. (auth)

28633 STUDIES ON THE RADIOSENSITIVE PHASE OF THE PRIMARY ANTIBODY RESPONSE IN RABBITS. I. THE ROLE OF THE MACROPHAGE. Pribnow, James F.; Silverman, Myron S. (Naval Radiological Defense Lab., San Francisco). J. Immunol., 98: 225-9(Feb. 1967).

Experiments were designed to test the hypothesis that macrophages are essential for antibody formation, and that radiation injury of these cells results in suppression of the immune response. Rabbits irradiated with 450 R of x radiation 24 hr prior to receiving both rabbit peritoneal macrophages incubated with bovine γ-globulin (BGG) and nonimmune lymph node cells from the macrophage donors were able to produce antibodies. Rabbits similarly irradiated and injected with sensitized macrophages only failed to show an antibody response. Normal recipients of these cells exhibited a typical primary antibody response although the titers were lower than the controls that received antigen alone. Normal and irradiated rabbits receiving lymph node cells incubated with antigen also failed to produce antibody as did irradiated rabbits receiving simultaneous injections of antigen and lymph node cells. Peritoneal exudate cells were harvested from rabbits that had received 450-, 550-, or 750-R doses of x radiation 24 hr previously. After incubation with BGG these cells were injected into normal rabbits. When donors had received 750 R, no antibody response was elicited in the recipients. The response to sensitized irradiated macrophages from rabbits that had received 450 or 550 R was variable. In no case did the degree of antibody response appear to depend on the number of sensitized cells injected. Irradiated recipients that received sensitized irradiated macrophages (550 R) and lymph node cells from normal rabbits did not form antibody. It was concluded that the initial radiosensitive phase of antibody formation consisted of preparation of the antigen by macrophages and the process of codification of information necessary for stimulating the synthesis of antibody. (BBB)

28634 EFFECTS OF THORIUM DIOXIDE UPON BLOOD CLOTTING AND PLATELETS. I. IN VITRO STUDIES. Hjort, P. F.; McGehee, W. G.; Rapaport, S. I. (Univ. of Southern California, Los Angeles). Throm. Diath. Haemorrh., 16: 333-53(Dec. 1, 1966).

The hemorrhagic diathesis induced by thorium dioxide was examined to determine what changes in clotting factors and platelets a thorium dioxide suspension produces as commonly used to block the reticuloendothelial system. Thorium dioxide was found to damage clotting factors and to interfere with platelet functions in vitro. Fibrinogen and factor V were progressively inactivated. Citrate did not prevent damage to these factors. Thorium dioxide was concentrated in the clot, which suggests that it binds to fibrinogen. Factors II, VII, IX, and X were also inactivated, and their inactivation could be prevented or reversed by citrate. Factors VIII, XI, and XII were not altered. Platelets became less adhesive and less subject to aggregation. These effects were more marked with unfiltered suspensions of thorium dioxide (TDS) than with filtered suspensions (Thorotrast). They were also increased by increasing the concentration of thorium dioxide, and the time and temperature of incubation. Thorium dioxide probably forms complexes with the clotting proteins, thereby making them less reactive. (BBB)

28635 CONTRIBUTION TO THE INVESTIGATION OF RADIATION DISEASE IN FOWLS. Rusov, C. (Institut za Primenu Nuklearne Energije u Poljoprivredi, Veterinarstvu, i Sumarstvu, Belgrade). Vet. Glas., 20: 23-30(1966). (In Serbian).

Development of radiation sickness and qualitative and quantitative changes in hematologic parameters were followed in 1-yr-old White Rock roosters exposed to 100-kV x rays (whole-body doses of 200, 400, 600, or 1200 R, delivered at 20 R/min). Symptoms of radiation disease were noted at doses of 400 R and higher and were similar to those seen in mammals. The lowest dose (200 R) stimulated leukopoiesis as seen by leukocytosis between the 7th and 21st day postirradiation. With doses of 400 R and above most hematologic values dropped within the 1st 24 hr. Leukopenia and lymphopenia lasted for about 3 days, at which time leukopoiesis was reestablished, and after 7 to 14 days postirradiation normal levels were reached for some leukocyte levels. After the highest dose (1200 R) the total leukocyte count fell from 17,360 to 11,500/mm^3 within 30 min. In surviving chickens this level rose to 22,050/mm^3 by the 42nd day then declined to slightly below control levels. (BBB)

28636 ELECTRON MICROSCOPIC INVESTIGATIONS OF CELL NECROBIOSIS. Wrischer, Mercedes (Institut Rudjer Boskovic, Zagreb). Protoplasma, 60: 355-400(1965). (In German).

Changes in cell ultrastructure during necrobiosis were investigated in different plant and animal subjects. Necrobiosis was induced by uv, x, and γ rays and other physical and chemical agents. One or several types of changes could be detected in cell organ-

elles. The same type of damage was usually observed in plant as well as in animal cells, but some types were different. Clumping or disappearance of osmiophilic structures were observed in the nuclei. Swelling of the proplastids could be detected in damaged meristematic plant cells. Swelling and vacuolation of the stroma occurred in chloroplasts. Ameboid deformations or formations of long christae were found as early changes in mitochondria. In some cases they were reversible. In more damaged cells, either swelling or decrease of the mitochondrial volume was observed. Cup-shaped deformations of the cisternae of the Golgi apparatus frequently appeared and were in some cases reversible. In animal cells fragmentation of the Golgi cisternae could also be noticed. An augmentation of the endoplasmic reticulum was observed in plant cells and in amoebae. Dilatation of nuclear membranes often occurred in damaged plant and animal cells. Damaged parts of the cells were eliminated either by enclosure into vacuoles (especially in plant cells) or by ejection of such parts out of the cell (as in animals). In damaged cells increased vacuolation, densification of the ground plasm (in plant cells), hyaline parts of the cells (in amoebae), lipid inclusions, and myelin figures were also noted. Changes in the cell ultrastructure during necrobiosis were generally independent of the type of the agent. However, the sequence of the damage of different cell organelles seemed to be dependent to a certain degree on the agent used. (BBB)

28637 RHEUMATOID ARTHRITIS IN HIROSHIMA AND NAGASAKI, JAPAN: PREVALENCE, INCIDENCE, AND CLINICAL CHARACTERISTICS. Wood, James W.; Kato, Hiroo; Johnson, Kenneth G.; Uda, Yutaka; Russell, Walter J.; Duff, Ivan F. (Atomic Bomb Casualty Commission, Hiroshima). Arthritis Rheum., 10: 21-31(Feb. 1967). (ABCC-3-66).

During the course of a long-term follow-up of large fixed population samples in Hiroshima and Nagasaki, Japan, to evaluate effects of exposure to atomic bombing, observations were made relative to rheumatoid arthritis. Attempts were made to establish its prevalence, to estimate incidence, to characterize the disease as seen in this population, and to consider any relation between exposure and its prevalence. Four groups were examined: Group 1, exposed within 2000 m of the hypocenter and experienced acute radiation symptoms (epilation, bleeding, or oropharyngeal lesions); Group 2, exposed within 2000 m of the hypocenter but did not experience acute radiation symptoms; Group 3, exposed between 3000 and 3499 m from the hypocenter; and Group 4, located beyond 10,000 m from the hypocenter or not in the city at the time of the bombing. Among the 16,000 subjects examined in Hiroshima and Nagasaki from 1958 to 1964, the prevalence of definite rheumatoid arthritis was 0.35% and the estimate of incidence was 45 per 100,000/yr. Subjects with rheumatoid arthritis had an increased frequency of AB and a decreased frequency of O type blood as compared with the total study population. In this sample, the relative risk of rheumatoid arthritis appeared to be 3.86 times greater for a subject with type AB than for one with type O blood. No relation was detected between the disease and exposure to atomic bombing. It was previously suggested that rheumatoid arthritis is due to somatic mutation. The lack of any association between rheumatoid arthritis and irradiation from the atomic bombing is strong evidence against this hypothesis. All four patients with rheumatoid arthritis who developed cancer were exposed within 1500 m from the hypocenter. (BBB)

28638 IMMUNITY OF DOGS TO ANCYLOSTOMA BRAZILIENSE INFECTION FOLLOWING VACCINATION WITH X-IRRADIATED ANCYLOSTOMA CANINUM LARVAE. Miller, T. A. (Univ. of Glasgow, Bearsden). J. Amer. Vet. Med. Ass., 150: 508-15(Mar. 1, 1967).

Vaccination of pups when 3 and 4 months old by subcutaneous inoculation of 2 doses of 40-kR-irradiated Ancylostoma caninum larvae protected the pups when 5 months old against the establishment of adult hookworms from a challenge inoculation of normal Ancylostoma braziliense larvae, with reductions in worm burdens in the vaccinated pups of 90% compared with the worm burdens in the control pups. Irradiated A. caninum larvae protected pups against establishment of A. braziliense infection as well as it did against A. caninum infection. As a result of the apparent absence of pathogenesis of A. braziliense infection of pups, except for a slight hypoproteinemia, differences in growth rates or hematologic measurements were not observed between vaccinated and control pups infected with A. braziliense. Prior vaccination with x-irradiated A. caninum larvae prevented hypoproteinemia in the vaccinated pups during challenge infection with A. braziliense. This interspecific protection, following use of x-irradiated A. caninum vaccine in pups, may have practical significance in prevention of creeping eruption associated with infection in man with A. braziliense larvae. (BBB)

28639 SOURCES OF OCCUPATIONAL EXPOSURE TO IONIZING RADIATION. Felton, Jean Spencer (Univ. of California, Los Angeles). pp 136-61 of Radiodermatitis. Epstein, Ervin (ed.). Springfield, Ill., C. C Thomas, 1962.

Occupational exposure to radiation is surveyed, with a discussion of the following aspects of the subject: historical background; type of personnel exposed; production, use, and disposal of fissionable material; use of nuclear reactors; production and use of radioisotopes; operation of particle accelerators; and use of x-ray devices in medical and industrial practice. A comprehensive compilation of reports of excessive occupational exposure to radiation is also given. Radiodermatitis still is being reported among physician, dentist, osteopath, and chiropractor users of x rays. This occurs even though the principles of protection of both operator and patient are well known. Recent institution of new regulatory practices providing for reporting and inspection of all radiation sources has brought to the attention of many local health departments the existence of outdated and inadequately shielded equipment. Through the educational efforts attendant upon the enforcement of these new codes, poorly protected units may be eliminated. A review of some dermatologic injuries subsequent to the exposure to ionizing radiation emphasizes the need for persisting vigilance and the kinds of situations in which personnel are excessively exposed. The skin changes described ranged from erythema to ulceration to amputation, with malignant changes and even death. Workmen's compensation implications of radiation injury are also discussed. If a worker develops radiodermatitis or a severe radiation burn arising out of and in the course of his employment following an exposure to excessive amounts of radiation, which was causally related to his skin condition, this should be considered compensable in all jurisdictions as an accident by injury. Present laws should be amended to include the late effects of radiation injuries which might not be discernible or detectable for a number of years after the actual exposure. (BBB)

28640 CORNEAL NECROSIS AFTER X-RAY TREATMENT. Linnell, Paul C.; Wolter, J. Reimer (Univ. of Michigan, Ann Arbor). Eye, Ear, Nose, Throat Mon., 46: 328-34(Mar. 1967).

Corneal necrosis, cataract, expulsion of the lens, and shrinkage of the conjunctiva are reported as a late reaction after x-ray treatment of antrum carcinoma. This case is an example of the severe ocular complications which radiation therapy may produce. Necrosis of the cornea, and especially of the corneal endothelium, x-ray cataract, and extensive shrinkage and fibrosis of the conjunctiva developed as late radiation changes and caused loss of the eye, and finally, even prevented the use of a prosthesis. Such complications can often be prevented by shielding the eye during the radiation therapy. For a tumor in the left maxillary sinus, x-ray treatment was carried out with a total dose of 6400 to 7240 R to the tumor region, in 34 applications utilizing a special wedge filter through left anterior and left lateral anterior facial fields. Photophobia associated with hypersecretion and a scratchy sensation in the left eye developed soon after the completion of this radiation treatment. Lens opacities are the more frequent complication of exposure of the eye to ionizing radiation. High voltage irradiation in the range of a total dose of 500 to 1000 R has been found to be cataractogenic. However, a single dose of 200 R has also been shown to produce cataract. Cornea and conjunctiva react to total x-ray doses of about 2000 R with hyperemia and edema early after treatment. Scarring or necrosis may occur later, and especially when larger x-ray doses have been used. Degeneration as well as drying and epidermidalization of the conjunctiva and cornea have been observed. The so-called early reactions to radiation usually begin 1 to 3 weeks after exposure. The late reactions may develop after months or even years. Decrease of corneal sensitivity, up to complete anesthesia, is a typical early sign of radiation damage of the cornea. Corneal ulcers of this type have a prolonged chronic course and may eventually heal with much neovascularization and scarring. Secondary infection is the main danger and often causes loss of the eye. Usually, the treatment of radiation defects of the cornea is conservative. Topical steroids in combination with prophylactic antibiotics are indicated. (BBB)

28641 HEMOPOIETIC REGENERATION IN CONTROL AND RECOVERED HEAVILY IRRADIATED DOGS FOLLOWING SEVERE HEMORRHAGE. Perman, Victor; Sorensen, Dale K.; Usenik, Edward A.; Bond, Victor P.; Cronkite, Eugene P. (Brookhaven National Lab., Upton, N. Y.). Blood, 19: 738-42 (June 1962).

Regeneration of the bone marrow following single or repeated doses of radiation appears to be complete as evidenced by a return of blood counts to the normal range. In the studies described, dogs given lethal doses of radiation and successfully treated with maintenance therapy 1 to 2 yr previously were stressed by severe bleeding, and the regenerative capacity of hemopoietic tissue as evidenced by the rate of recovery of blood counts was compared with control nonirradiated dogs. The recovered irradiated dogs had received either 400, 420, or 460 R of whole-body radiation.

Baseline values, including hemoglobin, hematocrit, red blood cells, reticulocyte, white blood cells, platelets, and differential cell counts, were established on all dogs three successive days prior to stressing by bleeding. The dogs, under pentothal anesthesia were bled via the femoral artery on three successive days. Twenty % of the calculated blood volume was withdrawn at each of the first two bleedings and variable amounts (12 to 20%) at the last bleeding. All dogs tolerated the first two bleedings with only minor changes in clinical condition. During the last withdrawal of blood it was necessary to discontinue bleeding due to severe hypotension in 3 of the 15 dogs, which was corrected by the administration of autologous plasma. All dogs were active and alert 24 hr after the last bleeding. The drop in hematocrit for all dogs ranged from 30 to 52%, with a mean drop of 37 to 40% for the various groups. The red blood cell and hemoglobin drop was of the same order as the drop in hematocrit. Similar changes in hematologic parameters were noted in control and irradiated dogs, indicating complete functional recovery of the previously irradiated marrow. (BBB)

28642 THE RADIOTHERAPEUTIC LUNG. Danrigal, A.; Raveleau, R.; Richier, J.-L.; Guelfi, J. (Centre Hospitalier Regional, Rennes, France). Sem. Hop. Paris, 37: 432-9(Feb. 2, 1961). (In French).

Etiologic, clinical, radiologic, diagnostic, and therapeutic aspects of lung injury produced by ionizing radiation are considered and are exemplified by several patients. Some individuals seem to be predisposed to radioinduced pulmonary injury, such as those with tuberculosis and atherosclerosis, but generally it is impossible to predict abnormal reactions of the lung to irradiation. Radioinduced lung lesions occur in 6 to 20% of chest-irradiated patients, and may occur during, soon after, or years after irradiation. Two types of reactions are noted: the early reaction is an acute exudative one and the late reaction is seen as pulmonary fibrosis. Case histories are recounted and pulmonary radiographs shown to illustrate the manifestations of these reactions. Secondary complications of radioinduced lung injury may include hemoptysis, infectious diseases, reactivation of tuberculosis, and cardiorespiratory insufficiency. Since treatment is relatively ineffective, prevention of radioinduced lung injury is essential and can best be accomplished by attention to the following aspects of technique; careful selection and location of portals, direction of the beam, doses used, and fractionation of the dose. (BBB)

28643 TISSUE TRANSPLANTATION IMMUNITY IN THE ADULT NEWT, DIEMICTYLUS VIRIDESCENS. III. THE EFFECTS OF X-IRRADIATION AND TEMPERATURE ON THE ALLOGRAFT REACTION. Cohen, Nicholas (Univ. of California, Los Angeles). J. Exp. Zool., 163: 231-9(Dec. 1966).

Graded doses of x irradiation, from 500 to 3000 R, inhibited destruction of Diemictylus allografts at 23 ± 0.5°C for at least as long as the survival time of the hosts (up to 35 days). Lymphocytes were observed in 20% of the grafts whose hosts received 500 and 1000 R but they were present in far weaker concentrations than seen in any control grafts at all stages of rejection. No lymphocytes were evident in any grafts on hosts irradiated with 1500, 2000, and 3000 R. The effects of various temperatures on allograft rejection in the newt were also examined. There was no difference in the mean survival times of grafts maintained at 30 and 23°C. At 20°C, however, hemeostasis and hemorrhaging were significantly delayed by a factor of 1.6 and 1.7 times, respectively, when compared with the findings at 23°C. At 10 to 15°C, no hemeostasis or hemorrhaging were displayed for 191 days after transplantation. Lymphocytes, however, were apparent in very low concentrations in the tissues of some of the grafts, and localized destruction of a few melanophores were noted. Two grafts maintained at 10 to 15°C for 155 days and then transferred to 20°C were completely destroyed within 36 days. This destruction was more rapid than for grafts initially maintained at 20°C. (BBB)

28644 LEUKEMOGENESIS WITH IONIZING RADIATIONS IN NEONATAL MICE OF THE BALB/c/Cb/Se SUBSTRAIN. Ribacchi, Rodolfo; Milia, Ugo; Paoletti, Icilio; Giraldo, Gaetano; Jantorni, Primo (Univ., Perugia, Italy). Lavori Ist. Anat. Istol. Patol., Univ. Studi Perugia, 25: 47-55(1965). (In Italian).

Radiation leukemogenesis in BALB/c mice of both sexes was studied. Two groups of mice were irradiated with 400 and 500 R, respectively, in fractionated doses of 100 R each at intervals of 4 to 5 days. The treatment was begun in newborn mice, less than 24 hr old, and was terminated on the 20th and 25th days of the respective groups. The incidence of lymphoid tumors in irradiated mice of the first and second groups was 50.8% and 63.1% at the mean age of 202 and 179 days, respectively. Of 43 lymphoid tumors observed, 20 (46.5%) were lymphosarcomas and 23 were lymphatic leukemias. Lymphosarcomas developed more frequently in females than in males. The average age at which they occurred was less than that for lymphatic leukemias. Other tumors, namely one mammary gland carcinoma, one hepatoma, one sarcoma, some lung adenomas, granulosa cell tumors, and tubular adenomas of the ovary, were also observed. (BBB)

28645 POSTACTINIC SIGMOIDITIS WITH A PSEUDOTUMOR: RADIOLOGICAL PICTURE. (PRESENTATION OF A CLINICAL CASE). Chianura, Gerardo (Univ., Bologna). Ann. Radiol. Diagn. (Bologna), 38: 498-503(1965). (In Italian).

A 76-yr-old female patient was treated 18 yr previously for cancer of the endometrium. She had received an x-ray dose of 4000 rad fractionated over 22 days and intracavitary implantation of Ra (3000 mg-hr). Five yr later she was reirradiated for a suspected recurrence of the tumor, a 3000-rad x-ray dose being directed toward the vagina in a 20-day fractionated course. No symptoms were noted until 13 yr later, when abdominal cramps and loss of weight occurred. Radiography at that time revealed what appeared to be a tumor in the rectum with considerable reduction of the lumen diameter. Surgery was performed on the tentative diagnosis of a secondary intestinal tumor. However, histologic examination of the biopsied specimen revealed a diffuse hyperplasia of the intestinal mucosa of a papillomatous type. There were also areas of fibrosis representing radiation damage, with recanalization of the occluded blood vessels in the submucosa. It is concluded that both the proliferative and degenerative changes were probably a result of previous irradiation of the intestine. (BBB)

28646 CONSIDERATIONS ON THE PATHOGENESIS OR POSTRADIOTHERAPY AND POSTCOBALTOTHERAPIC DENTAL LESIONS. THERAPEUTIC DEDUCTIONS. Delaire, J. (Faculte de Medecine, Nantes, France); Billet, J.; Tardiveau, J.; Bonnard, J.; Kerebel, B. Actual. Odonto-stomatol., 70: 157-84(June 1965). (In French).

Radioinduced injury to the oral region, and particularly to the teeth, as a result of ^{60}Co and conventional x-ray therapy is examined, with emphasis on the pathogenesis of the injury. Various pathogenic concepts that have been advanced to account for such injury are discussed and critically examined. Three main concepts are proposed that relate the lesions to disorders arising in the nervous system, bone, and salivary glands, respectively. Arguments are presented on the basis of clinical and histologic findings for attributing the lesions in the crown of the teeth to inhibition of salivary secretion because of injury to the salivary glands. Prophylactic and therapeutic measures for radioinduced dental lesions are cited. Limitation of the irradiation field is one of the most important means of preventing injury. Any carious teeth in the field should be extracted before irradiation and a prosthesis provided. If extensive irradiation of the salivary glands is unavoidable, all the teeth should be extracted, preferably 15 days to 3 weeks prior to irradiation. After irradiation, good oral hygiene is essential. It is feasible to extract teeth after irradiation without risk of osteoradionecrosis as long as the bone has not been irradiated. (BBB)

28647 KIDNEY SURGERY DURING VARIOUS PERIODS OF ACUTE RADIATION SICKNESS: EXPERIMENTAL STUDY. Glukhov, Yu. D. Voenno-Med. Zh., 2: 28-31(Feb. 1965). (In Russian).

Adult rabbits were submitted to kidney surgery after irradiation with 650-R, whole-body doses of 160-kv x rays. At various stages during the resulting acute radiation sickness one kidney was exteriorized and its upper portion excised under ether anesthesia. In surgically treated, nonirradiated controls, recovery from renal resection was satisfactory in 2 to 3 days as noted by behavior of the animals. Irradiated, nonoperated control rabbits also recovered to some extent several days after irradiation, then in the second week of radiation sickness, hemorrhagic phenomena were noted. Four of 20 rabbits in this group died. Marked leukopenia was noted in the third week, but surviving rabbits had normal leukocyte counts by the 5th to 10th week. In the third group of rabbits, operated on after irradiation, the least effects of surgery were noted when it was done within 3 days of irradiation. The mortality rate was higher when surgery was performed 4 to 5 days postirradiation. Healing of the incision was slow and urinary excretion impaired. Surgery on the 11th to 12th day postirradiation resulted in 90% mortality, and the animals showed greater reaction to ether anesthesia. Hemorrhagic syndrome was severe and the wound edges separated. Marked decreases were noted in hemoglobin, leukocytes, and nonprotein nitrogen levels in blood. Surgery during the late postirradiation recovery period (24th to 28th day) was followed by normal recovery and no deaths, but recovery was slower than in nonirradiated controls. It is concluded that surgery should not be performed during the 2nd postirradiation week. The most favorable times are during the latent or the late phase after irradiation. (BBB)

28648 STUDY OF EMBRYONIC DEVELOPMENT AND REGENERATION IN THE EMBRYO OF THE PLANARIAN POLY-

CELIS NIGRA (TURBELLARIE, TRICLADE). LeMoigne, A. (Univ., Paris). J. Embryol. Exp. Morphol., 15: 39-60(Feb. 1966). (In French).

X irradiation of isolated embryos and intact cocoons was conducted in morphogenetic studies. Seven stages were distinguished in the development of the Polycelis nigra embryo, and a demonstration of the existence of neoblasts in the embryo was attempted. Embryonic cells similar to neoblasts were found at the end of stage 4 and were numerous at stage 5. Older embryos could regenerate even if beheaded before the end of their embryonic development at a stage when nervous trunks were not yet differentiated (stage 5). Formation of the blastema is then delayed; the embryonic tissues and nervous trunks differentiate first. When they are sufficiently differentiated, the blastema can develop. This is new evidence in favor of the part played by the nervous system in the regeneration of planaria. The differentiation process in the embryonic tissues is not modified by the regeneration of a missing part. Moderate doses of irradiation (750 to 2000 R) during embryonic development, starting from stage 4, did not prevent differentiation and hatching, but the embryos were incapable of regenerating. The neoblasts, being more sensitive to irradiation, are more quickly destroyed. They are distinct from the other tissues as early as stage 4, though the definitive organs are not morphologically distinguishable. Various abnormalities were caused by x irradiation. (BBB)

28649 REACTIVE CHANGES IN THE NEUROSECRETORY NUCLEI OF THE HYPOTHALAMUS AND SOME GASTRIC GLANDS OF DOGS THAT HAD SUFFERED FROM RADIATION SICKNESS. Genis, E. D.; Kienko, L. D. Fiziol. Zh., Akad. Nauk Ukr. RSR, 13: 95-100(Jan.-Feb. 1967). (In Ukrainian).

The reaction of the organism to ionizing radiation was considered as a state of extreme stress. In realization of adaptation reactions of the organism to irradiation a great role was played by the neuroendocrine regulating system. The state of the hypothalmic-hypophysic-suprarenal system in the genesis of the late post-radiation effects was studied. Data characterizing the morphological and histochemical changes in the neurosecreting elements of the hypothalamus and hypophysis and in the suprarenal, thyroid, pancreas, and sex glands of dogs suffering from radiation sickness were reported. The animals were inspected from one to three years after whole-body x-irradiation at doses of 600 R and subsequent complex medical treatment in the period of development of acute radiation sickness. For determination of the morpho-functional state of the endocrine organs, aside from the usual histological studies, determinations were made of the concentration of lipoid and carbamile groups of ketosteroids in the suberin of the suprarenals and interstitial tissue of seminal cells. In the hypothalamus the state of the neurosecretion in the neurons of the supraoptical and paraventricular nuclei was investigated. The histochemical data obtained indicated that together with the development of destructive and schlerotic processes in the endocrine organs, disturbances in the concentration of the hormone precursors was observed in the suberin of the suprarenal of dogs with radiation sickness. In the hypothalamus extensive vascular and degenerative changes of the neurosecreting nuclei, combined with changes in the endocrine glands, were observed. The study confirmed assumptions on the extreme duration of the post radiation recovery of the structures, function of tissues of animal organisms, and the possible exhaustion and change of the neuroendocrine regulatory function. (tr-auth)

28650 EFFECT OF REPEATED GAMMA IRRADIATIONS ON TISSUE TRANSPLANTABILITY. Arustamov, D. L. Med. Zh. Uzbek., No. 11, 28-30(Nov. 1966). (In Russian).

Four sets of rabbits and rats were irradiated. In the first set (the control group), tissue was transplanted from healthy animals to unirradiated animals. In the second group, the recipient was irradiated. In the third group, the donor was irradiated, and in the fourth group, the donor and recipient were both irradiated. The animals were given 20 R of ^{60}Co γ radiation per day with a total dose of 100 R for the rabbits and 500 R for the rats. One day after the last irradiation, a flap of skin 2 × 3 cm in size was transplanted to the rabbit, and 1 × 2 cm in size was transplanted to the rat. The state of the transplant was observed, and the region of the transplantation was subjected to histological study after killing animals at 3 to 56 day intervals after the skin graft operation. The results showed that the skin flap adhered on the average 9.5 days in the rabbits and 14.5 days in the rats of the control group. The corresponding figures were 18.6 and 23 days, when the donor and recipient were both irradiated. Irradiation decreased the immunological response of the donor to the foreign transplant. (TTT)

28651 DISTRIBUTION OF ^{210}Po IN MICE FOLLOWING INHALATION OF ^{210}Po-TAGGED TOBACCO SMOKE. Soeremark, R.; Hunt, V. R. (Forskningradens Laboratorium, Studsvik, Sweden. Harvard Univ., Boston). Arch. Environ. Health, 14: 585-8(Apr. 1967). (NYO-3481-11).

It is shown that ^{210}Po, when associated with tobacco leaf and used in a simulated smoking procedure, can be inhaled and deposited in the lungs of experimental animals. Distribution of ^{210}Po can then be observed in many organs of the body. (auth)

28652 EXPERIMENTAL EFFECTS OF GAMMA IRRADIATION OF THE ANTERIOR SEGMENT IN RABBITS. Jammet, H.; Dollfus, M.-A.; Haye, C. Bull. Soc. Ophtalmol. France, 64: 267-9(Mar. 1964). (In French).

To gain more knowledge on the possible effects of thermonuclear explosions on the eye, the eyes of rabbits were exposed to ^{60}Co γ-ray doses of 750, 1000, 1500, 3000, and 6000 rad. Periocular epilation was consistently noted, the latent period being proportional to the dose. Corneal epithelial erosion was seen as well as edema of the subjacent corneal parenchyma and a marked endothelial reaction. Marked cellular reactions were also observed in the anterior chamber. Thus, cells appeared in large numbers in aqueous humor; sometimes leukocytes predominated and at other times erythrocytes. The number of erythrocytes reached a maximum 4 days after irradiation of ~10,000 cells/mm^3, and by the 15th to 27th day they had disappeared. There appears to be a transitory postirradiation increase in the permeability of the ciliary body which is only seen if this body is directly irradiated; if locally shielded it does not occur. The Tyndall phenomenon is seen within 20 min after exposure, and its intensity is dose dependent. With the 6000-rad dose, opacity of the lens was evident in about a month, with 3000 rad ~6 weeks, with 1500 ~3 months in 100% of the rabbits. Cataracts were more frequent in young than old rabbits. The cataractogenic dose of ^{60}Co γ rays seems to begin at 500 rad. (BBB)

28653 PERIPHERAL BLOOD CHARACTERISTICS OF PERSONNEL EXPOSED TO A ULTRAHIGH-FREQUENCY ELECTROMAGNETIC FIELD. Krustanov, L.; Goshev, Khr. Voenno-Med. Delo, No. 4, 41-6(1966). (In Russian).

Changes in the peripheral blood of personnel working around UHF electromagnetic fields in anti-aircraft and air force installations were studied. Some results are tabulated. Characteristic of the findings was a tendency towards increased leukocyte counts (upper limits of normal) in a substantial number of personnel. Changes were more pronounced in personnel with longer tours of duty. (ATD)

28654 RADIATION EFFECT ON THE BODY WEIGHT INCREASE OF THE TOAD WITH CLOSED CLOACA. Go, Manrui; Maeda, Yoshiko; Yamashita, Junko (Osaka Univ.). Sanfujinka No Shimpo, 16: 203-4(July 1964). (In Japanese).

The radiation effect on the body weight increase of the toad with the cloaca ligated was studied. Since the toad does not drink water via the mouth, its increase of body weight by water uptake has been considered due to the osmosis through skin. In present investigation, ^{60}Co was used to irradiate the toad before ligation of cloaca to study the effect of irradiation on the water metabolism through a biological membrane. Toads (Bufo vulgaris) collected in January were irradiated with 500 and 1000 R for 15, 30, 60 min, 2, 4, and 8 hr. After irradiation the cloaca of toad was ligated with a surgical suture, then the body was immersed in water and the body weight increase was measured. The results showed that the rate of body weight increase decreased as the dose of irradiation increased. It has been reported that the irradiation affects biological membrane permeability; for example, ^{24}Na passage through rabbit urinary bladder and erythrocyte membranes is enhanced after irradiation. In the present study, irradiation at the given dose may not have affected the pituitary gland, but it may have affected the functions of kidneys and adrenals and thereby changed water metabolism. However, under the experimental conditions used the time may have been too short to show the lattice effect; therefore, the increase of body weight after irradiation was considered as reflecting a decrease of water permeability in skin. (BBB)

28655 DANGERS OF SUPERSONIC AIR TRAVEL. Offerhaus, L. Ned. Tijdschr. Geneesk., 109: 1927(Oct. 9, 1965). (In Dutch).

Theoretical calculations of the radiation dose received during supersonic flight seem to be of less value than actual measurements, which indicate higher levels of activity than would have been predicted by the theoretical model. Although it is a general rule that the radiation problem is less important for passengers than crew, it is necessary that they spend less than the limiting amount of time at high altitudes calculated for each year. The radiation values should be compared to those which the population in general receives. A passenger with ten flights each year would accumulate 300 times greater exposure to radiation than that recommended for radiological workers. Particular problems for the pilot also include the effects of sudden decompression. (BBB)

28656 TERATOGENIC ACTION OF X RAYS ON THE RAT EMBRYO. II. RADIOPROTECTIVE EFFECT OF HYPOTHERMIA. Marois, Maurice (Faculte de Medecine, Paris). Bull. Acad. Nat. Med. (Paris), 150: 186-93(Mar. 22, 1966). (In French).

Developmental anomalies were examined in rats irradiated on the 10th day of pregnancy, some pregnant animals being irradiated 30 min after a 2-hr stay in a refrigerator at 0°C. The x-ray doses used were 100, 125, 150, and 200 R. Hypothermia was carried out under conditions that also produced hypoxia and hypercapnia. The results showed that hypothermia, associated with these other conditions, conferred a protective effect, in that anomalies of the central nervous system (especially meningocele, anencephaly, and exencephaly). The lethal effect of x radiation, as determined by the number of fetuses resorbed, was also ameliorated by hypothermia. In the control series the incidence of anomalies was higher after 200 R than 100 R. Although hypoxia and hypercapnia may in themselves be teratogenic, no fetal anomalies were observed in the nonirradiated control animals. (BBB)

28657 FIVE CASES OF RIB FRACTURES FOLLOWING POST-OPERATIVE X-RAY TREATMENT OF THE BREAST CANCER. Kikuchi, Akira; Yamaguchi, Koichi; Shida, Hisao; Shinohara, Teruhiko; Uemura, Kazuo; Toyokawa, Yasuo; Hatayama, Takeshi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 264-87(1963). (In Japanese).

A review of the literature (79 references) revealed 81 cases of radiation-induced rib fractures consequent to radiotherapy for mammary carcinoma. In the authors' clinic from 1959 to 1962 there were 5 patients out of 56 treated postoperatively with x rays for carcinoma of the breast who subsequently developed fractures of the rib. The periods from completion of treatment to discovery of the lesions varied from 4 to 20 months. The latent periods were shorter than reported previously. The site of the rib fractures was limited to 2nd, 3rd, and 4th ribs and to the anterior or anterolateral segments. Fractures were not seen in the ribs included in the tangential field. The tissue dose at the site of fracture, except in one case, ranged from 2800 to 3500 R. Individual biological factors other than the dose delivered seemed to have contributed to the development of the rib fractures. In 4 of 5 fractures which were followed up during a period of more than eight months, complete union by extensive callus formation appeared in 4 to 8 months after discovery of the fracture. No correlation between the dose delivered to the rib and the duration of the latent period, or the healing rate of the fractures, could be detected. Moreover, radiation changes recognized clinically in the skin, lung, and bone were not consistently related to the magnitude of the dose. (BBB)

28658 THOROTRAST RETENTION FOLLOWING ANGIOGRAPHY: A CASE WITH POST-MORTEM STUDIES. Mackenzie, K. G. F.; Preston, C. D.; Stewart, W. (General Hospital, Shotley Bridge, Eng.). Clin. Radiol., 13: 157-62(Apr. 1962).

A case was reported of a man dying 19 yr after bilateral femoral arteriography with Thorotrast. The deposits of ^{232}Th were demonstrated by autoradiography and scintillation counting, and dose calculations were made based on physical estimations. Chemical analysis of liver tissue revealed 200 mg thorium/50 g of formalin-treated liver. Histological sections of liver, spleen, pancreas, and lymph nodes along the pancreatic chain showed necrosis of cells, dense over-growth of fibrous tissue, variable calcium deposits in relation to the thorium deposits, and variable Thorotrast deposits, the heaviest being in the lymph nodes. While the bone marrow contained macrophages carrying deposits of thorium, the hemopoietic tissues were not damaged severely. The injected thorium dioxide, taken up by the reticulo-endothelial system is radioactive and almost completely retained giving a high local dose of radiation in the most heavily contaminated areas. The progressive cellular damage and reactionary fibrosis produced can, over a period of years, result in the fatal disorganization of vital abdominal organs. (BBB)

28659 PHOTOSENSITIVITY, A PHYSICAL ALLERGY CAUSED BY THE SUN. Taub, S. J. Eye, Ear, Nose, Throat, Mon., 45: 107; 110(Nov. 1966).

Sensitivity to uv radiation in humans is briefly reviewed. Photosensitivity is caused by direct exposure to the sun or to the rays of artificial fluorescent light. The uv radiations which are between 2900 and 4000 Å are the most important part of the uv spectrum because they are responsible for sunburn. It was previously thought that window glass protects by absorbing the sun rays while allowing penetration of the longer uv rays. However, photo-allergic contact dermatitis is almost always provoked by these long uv rays. Photo contact dermatitis may continue though the patient believes he is avoiding sunlight. These rays may reach the patient's skin through a window, even on a cloudy day. These conditions have been divided into photo-toxic and photo-allergic manifestations. Photo-toxic reactions can occur in any person if exposed to enough light and enough of the photosensitizer. In photo-allergy, drugs are the major cause of symptoms. One such drug, methylchlortetracycline causes a severe sunburn or dermatitis even after the usual recommended doses. Severe edema and redness of the face, hands, and feet may persist for weeks. (BBB)

28660 OBSERVATIONS ON EARLY PATHOLOGIC EFFECTS OF PHOTIC INJURY TO THE RABBIT RETINA: A LIGHT AND ELECTRON MICROSCOPIC STUDY. Fine, Ben S. (Armed Forces Inst. of Pathology, Washington, D. C.); Geeraets, Walter J. Acta Ophthalmol., 43: 684-91(1965).

Mild retinal lesions produced by a pulsed xenon light coagulator were compared with lesions produced by a ruby rod laser, and threshold lesions were examined to pinpoint precisely the site of early biologic response. Such ocular injury is of increasing interest because of possibilities of exposure to laser beams and flashes of nuclear explosions. Electron microscopic observations indicated that the site of earliest tissue change lies within the pigment epithelial cell, more specifically in the fragile system of smooth-surfaced endoplasmic reticulum occupying the apical and midzonal cytoplasm. In more severe lesions, a nonspecific granulation effect was observed in the pigment epithelium and photoreceptor cells, attributed to focal densification of cell membranes and of the adjacent cytoplasmic ground substance. Morphologic evidence is presented indicating the absence of trans-synaptic degeneration from the photoreceptor cells within the limited time interval (5 hr) of the experiments. The observations also confirm that the intracellular changes are nonspecific, varying only in degree of severity. The data suggest that primary thermal damage is limited mostly to the pigment epithelial cells and outer portions (i.e., from the perikaryon outward) of the photoreceptor cells, while the changes occurring in the innermost portions of the photoreceptor cells (i.e., internal to the perikaryon) are mostly secondary degenerative phenomena. (BBB)

28661 PATHOMORPHOLOGICAL FINDINGS IN COCKS AND HENS AFTER THE WHOLE-BODY IRRADIATION. Rodak, Ladislav; Cerna, Jitka. Vet. Med. (Prague), 11: 727-33(Dec. 1966). (In Czech).

Morphological changes were followed in 38 New Hampshire cocks and hens irradiated with a dose of 800 to 2000 R, the flow being 40 R/min, that decayed in the course of 11 days after irradiation. Morphological changes corresponded to the increasing radiation-doses. Most expressive macroscopical changes could be observed during the first days after irradiation. At this stage strong swelling of heads appeared, especially of wattle, and of the ventral side of the proximal third of neck. This is connected with strong circulation disorders arising after irradiation. Expressive haemorrhagic infarsation of oviduct was often ascertained in hens especially in the main albumen-producing and uterine sections. Most expressed changes of the gastrointestinal tract were found in the duodenum. Numerous intralobular necrotic foci were found microscopically in the liver of animals decayed on the first day following irradiation. Small amounts of hemosiderin in the Kupfer's cells of liver and in siderophagi of spleen have appeared. Contents of hemosiderin in these cells rose and was at its highest level on the 6th to 11th day after irradiation. (auth)

28662 A MODEL FOR RADIATION INJURY. V. ON THE TARGET THEORY. Sato, F.; Eto, H. (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1130-7(Nov. 1966).

The multi-target model is applied in some complicated systems of cells, and the survival curves are calculated. In the heterogeneous system, the survival curves have in general no exponential region and no extrapolation number. The survival curves from the cells having multiple modes of death are the same as those of single mode of death. The survival curves on colony count never regenerate with divided exposure in the full recovery of the cells due to the decrease of the mean colony size. Non-uniformity of the dose distribution gives rise to a concave survival curve even in single hit model. (auth)

28663 ALTERATIONS IN RADIOSENSITIVITY OF ASCITIC EHRLICH TUMOR UNDER THE INFLUENCE OF IRRADIATION IN VITRO. Efimov, M. L.; Nugmanov, E. U. (Kazakh Inst. of Oncology and Radiology, Alma-Ata, USSR). Vop. Onkol., 13: 54-7(1967). (In Russian).

Ehrlich ascites tumors were irradiated in vitro prior to each serial transplantation. Radioresistance was enhanced both by initial and subsequent exposures. Chromosome number was reduced from 46 to 44. There were no changes in the number of polyploid cells. (auth)

28664 CRANIOCEREBRAL TRAUMA INDUCED BY LASER RADIATION: A METHOD FOR EXPERIMENTAL PRODUCTION OF SUBDURAL AND SUBARACHNOID HEMATOMA. Brown, Thomas E.; True, Charles; McLaurin, Robert L.; Hornby, Peter;

Rockwell, R. James (Children's Hospital Research Foundation, Cincinnati). Life Sci., 5: 81-7(Jan. 1966).

Production of acute subdural and subarachnoid hematoma and cerebral edema in the rat by ruby laser radiation is described. Impacts of 10- to 50-J intensity directed onto the skull caused char of the periosteum and a necrotic area in the bone beneath this lesion. Fourteen of the 29 rats died within one hr after irradiation, and most surviving animals showed neurologic deficits after laser radiation to the skull. Temporary apnea was common. The laser impacts occasionally caused seizures, and often increased depth and/or rate of respirations. Subdural hematoma was found, as well as early cerebral edema of the ipsilateral cerebral hemisphere. Among the rats that died immediately after irradiation, the brain either appeared normal or diffuse subdural hemorrhage was present. Cerebral edema was not found when death occurred immediately after impact. Gross intraventricular hemorrhage was not seen. The subdural hematoma usually measured 3 to 4 mm in dia and beneath it the brain cortex frequently exhibited petechial hemorrhages and showed pressure defect from the hematoma. Under the hematoma, cortical changes were found that were similar to those described in cerebral contusion. The cortical lesion showed capillary dilitation, intravascular thrombosis, and occasionally rupture of the vessel walls. The neurons in this area were devitalized. Acute swelling of the oligodendroglia and changes in the cellular detail of the astrocytes were also seen. The tissue in general showed a pattern of intercellular vacuolization with prominent axon cylinders, consistent with cerebral swelling. (BBB)

28665 RISE IN CONGENITAL ANOMALIES OF THE LACRIMAL PASSAGES IN SOUTHERN FINLAND SINCE 1959. II. ABNORMALITIES OF THE LACRIMAL PASSAGES AND RADIOACTIVE DEBRIS. Vannas, Salme; Liesmaa, Martii (Univ. of Helsinki). Acta Ophthalmol., 43: 90-100(1965).

A recent considerable increase in the number of patients suffering from congenital anomalies of the lacrimal passages was tentatively attributed to increased environmental radioactivity as a result of fallout from nuclear weapons testing. Illnesses or medical treatment during pregnancy were not implicated in the increase of the anomalies in question. The survey included reports on 428 patients who were under 20 yr of age and who suffered from anomalies of the lacrimal passages between the years 1955 and 1963. A prominent increase in the frequency of anomalies of the lacrimal passages was observed in those born after 1959; periodicity was detected in the dates of birth of the persons affected. Most of the affected patients' dates of birth were preceded 6 to 7 months by a maximum radiation level from radioactive fallout. The genetic and somatic effects of radiation are reviewed and discussed in relation to the present findings. (BBB)

28666 INFLUENCE OF FRACTIONATED X-RAY DOSES ON PHENYLHYDRAZINE TREATED RABBITS. I. EFFECTS ON ERYTHROPOIESIS. Fantoni, A.; Botteghi, F. (Univ., Genoa). J. Nucl. Biol. Med., 10: 104-9(July-Sept. 1966).

Rabbits with severe phenylhydrazine induced anemia were exposed to daily doses of 25 R, 50 R, 75 R for six days without any relevant alteration of the erythropoietic function as evaluated by the hematocrit value and the reticulocyte count. Daily doses of 100 R for six days induced a significant decrease of the erythroid proliferation, with a ready recovery within eight days after the last x ray exposure. The same conditions with a preirradiation of 100 R for 3 days produced a severe and irreversible injury to the erythropoiesis. The present findings are discussed in view of the possibility of obtaining an erythrocyte population, the proliferation and differentiation of which, entirely occur under the effect of repeated irradiations. (auth)

28667 ON SOME LATE RESULTS OF RADIOTHERAPY OF CUTANEOUS ANGIOMAS. Boggio Robutti, G.; Francesconi, G. (Univ., Milan). Minerva Chir., 21: 323-31(Apr. 30, 1966). (In Italian).

The literature relating to radioinduced injury as a sequel to radiotherapy in childhood of angiomas in the skin is reviewed, and 114 such cases are discussed. In general, two types of late effects were seen: radiodermatitis of varying degree of severity and hypodevelopment of skeletal or soft tissues. Most of the patients were treated when only several months of age, a time when some tissues were incompletely developed. In some cases, particularly when treatment was given some years ago, faulty technique or incorrect dose calculation had caused severe radiodermatitis or hypoplasia. In some of the cases described, the cutaneous lesions caused by irradiation were cosmetically more objectionable than the angioma for which the treatment was given. In 67 of the cases some interference by irradiation in morphogenesis was evident, with growth inhibition of bone, cartilage, teeth, mammary glands, or ears being noted. Most of the cases showed injury in the facial region, with hypoplasia of jaw or cheek bones. Malocclusion of the teeth was another prominent finding. Only 19 of the patients were male, the other 95 being female. A long latent period before injury or maldevelopment was the rule. Numerous photographs are provided to illustrate the various types of lesions seen. (BBB)

28668 MODIFICATION OF SURVIVAL FROM MEDIAN LETHAL DOSES OF X RAYS AND HIGH-ENERGY PROTONS BY PREVIOUS ERYTHEMA DOSES OF SOFT X RAYS. Fox, Leo. Boston, Boston Univ., 1966. 125p.

Thesis.

Since interaction of radiation induced skin injury might be expected to modify the dose-time responses usually seen following whole-body radiation, it was felt that an experimental study to elucidate such possible interactions should be conducted. To this end, the effects of the following types of radiation and doses were determined on mice (CFW): soft x ray (30 Kvp) using doses of 750 and 1500 RAD; hard x ray (220 Kvp) using doses of 600, 650, 700, and 750 RAD; and soft protons (55 MeV) and hard protons (112 MeV) using doses of 650 RAD. Having established these control values, mice were exposed to combinations of soft x ray plus hard x ray, and soft x ray plus protons. In the x ray combinations, mice were exposed to skin doses 750 and 1500 RAD and then irradiated with whole-body doses of 220 Kvp x ray of 650 and 700 RAD. In the x ray plus proton combinations, mice were exposed to skin doses of 750 and 1500 RAD followed by exposure to whole body doses of 650 RAD of 55 MeV and 112 MeV protons. The results of exposure to the combinations of soft x ray and hard x ray when compared to whole-body radiation of hard x ray alone showed an increase in mortality by a factor of approximately 2 to 3. In addition, the mode of lethality was altered from the hematopoietic to the gastrointestinal mode. The combinations of soft x ray plus protons when compared with whole-body irradiations with protons alone showed increases in mortality by a factor of approximately six. (Dissertation Abstract)

Radiation Effects on Plants

Refer also to abstracts 28335, 28362, 28363, 28391, and 28422–28424.

28669 (YALE-2755-17) EFFECT OF IONIZING RADIATION ON FOREST TREES: ITS GENETIC AND CYTOLOGICAL IMPLICATIONS. Final Report. Mergen, Francois (Yale Univ., New Haven, Conn. School of Forestry). Apr. 24, 1967. Contract AT(30-1)-2755. 22p. Dep. CFSTI.

SEED — radiation effects on development of tree, effects of dose on elder, oak, and pine, γ

SEEDLINGS — development of, effects of γ-irradiated seed on

POLLEN — radiation effects on germination of, effects of dose on oak and pine, γ

GAMMA RADIATION — effects on development of trees in oak-pine forest, chronic, low-dose

IRRADIATION FACILITIES — use of γ, for chronic exposure of forest trees

SEED — radiosensitivity of tree, effects of environment on γ (C.H.)

28670 DIFFERENCES IN SUSCEPTIBILITY TO APPLE POWDERY MILDEW OBSERVED IN MCINTOSH CLONES AFTER EXPOSURE TO IONIZING RADIATION. McIntosh, D. L.; Lapins, K. (Canada Dept. of Agriculture, Summerland, B. C.). Can. J. Plant Sci., 46: 619-23(Nov. 1966).

The possibility that certain desirable horticultural characteristics may be induced in commercial apple varieties by exposing dormant shoots to ionizing radiation was investigated. A thermal neutron-induced color mutant of Cortland, Nova Red variety, exhibited a much higher degree of resistance to apple powdery mildew, caused by Podosphaera leucotricha, than the nonirradiated original clone growing beside it. Also 27 clones of McIntosh, grown from scions exposed to γ irradiation while dormant and selected originally for their compact growth habit, displayed striking differences in their susceptibility to mildew. Dormant scions were cut in midwinter, stored, and exposed in the spring to ^{60}Co γ rays at dose levels of 3750 to 5000 RAD. The scions were then grafted on 10-yr-old apple seedling trees. The lowest 10 buds from each shoot growing from the graft were used for further propagation. Most of the 27 clones examined displayed moderate mildew susceptibility comparable to that of nonirradiated McIntosh grown in this region. Some were extremely susceptible, a few were quite resistant. No correlation was observed between compactness of growth habit and susceptibility to mildew. These differences in mildew susceptibility are attributed to changes caused by the radiation treatment. (BBB)

28671 THE ACTION OF SHORT WAVELENGTH RADIATION ON THE WEAK-LIGHT MOVEMENT OF MOUGEOTIA CHLORO-

PLASTS. Haupt, Wolfgang; Schoenfeld, Ingrid (Univ., Tuebingen, Ger.). Z. Botan., 51: 17-31(1963). (In German).

The interference of near uv (370 nm), red, far-red irradiation in the induction process of the chloroplast movement in Mougeotia was investigated. Once the saturation of the red effect has been reached, the far-red requirement for reversing the induction is nearly independent of the energy of the inducing red. However, inductions by uv require much more far-red in order to be reversed, and even then the reversibility is incomplete. Induction caused by polarized red light, vibrating across the long axis of the cell, can be reversed if followed by red light vibrating parallel to the cell axis. This reversing effect is nearly independent of the duration of the dark period up to at least 15 min between the irradiations. Reversal is not possible by parallel vibrating uv irradiation. The reversibility of the red effect by far-red can be inhibited by uv given between red and far-red, but not by uv preceding the red. Thus, uv seems to have a stabilizing effect on the phytochrome pigment in the far-red absorbing form. The uv effect is independent of the orientation of the vibration plane. This stabilizing effect is only temporary; a few minutes after uv irradiation, reversal of the red effect by far-red is again possible. In a quite different phytochrome response, viz., the cotyledon growth of mustard seedlings, the same interference between red, far-red, and uv was noted. The antagonism between perpendicular and parallel vibrating red light cannot be influenced by uv, given between the 2 irradiations. The stabilizing uv effect evidently has nothing to do with the photomorphogenetic high-energy reaction (blue far-red reaction system). (BBB)

28672 EFFECTS OF ^{60}Co GAMMA RAYS ON RESPIRATION RATE, LOSS IN WEIGHT, AND APPEARANCE OF GREEN AND RIPE SHAMOUTI ORANGE FRUITS. Kahan, R. S. (Israel Atomic Energy Commission, Yavne); Aharoni, Y.; Lattar, F. S. Israel J. Agr. Res., 15: 201-7(Oct. 1965).

Shamouti oranges were γ irradiated at a dose rate of 400 Krad/hr to test the effects on the respiration rate of the fruit, loss in weight, and color changes in the skin of near-ripe green oranges. The effects of radiation on freshly picked, ripe fruit and on fruit stored for one month prior to irradiation were also compared. Green oranges irradiated with 21 to 175 Krad suffered severe skin damage and natural degreening was retarded. Doses of 63 Krad did not cause any skin damage to ripe fruit. There were no textural or other macroscopic changes in the pulp of either green-skinned or ripe oranges. Irradiation brought about a several-fold increase in the respiration rate of freshly picked fruit, both green and ripe; the increase was much smaller in fruit stored for 1 month before irradiation. The maximum increase occurred during the first 2 days after irradiation, but the rates of increase were not proportional to the radiation dose. Irradiation of freshly picked oranges resulted in increased loss of weight in storage. This increase apparently depended on the interval between picking and irradiation. There was no weight loss due to irradiation applied 1 month after picking. (BBB)

28673 THE EFFECT OF α RADIATIONS ON PLASMA AND CELL ORGANS OF ALLIUM CEPA EPIDERMIS. Stadelmann, Edward (Univ., Freiburg, Switzerland). Protoplasma, 54: 247-53(1961). (In German).

The internal epidermal structures of yellow varieties of Allium cepa were exposed to α irradiation from a 3.4 mCi ^{210}Po source with an activity of 0.088 mCi/mm^2 of surface. Cellular changes observed after irradiation were similar to those observed during normal aging processes, probably because of the small size of the organizational unit. With a dose intensity of 44×10^7 dis/mm^2, which corresponded to an irradiation interval of 3 min with the source used, changes observed in the chondrioma and plastidome were completed within 50 min. Only a few of the long chondriosomes were broken. A few became slightly thickened and shortened, but several became bent and tended to form rings. The leukoplasts tended to become round, but volume changes were not observed. The nuclei developed some areas that appeared bright when viewed with phase contrast. No alterations of the spherosomes were observed. Colorations of the hyaloplasma vacuoles varied somewhat, and the viscosity of the plasma first decreased after irradiation, and then increased. At a higher irradiation intensity of 1.4×10^9 dis/mm^2 the changes observed were more pronounced than after the lower intensity, and appeared within 5 to 10 min after irradiation. (BBB)

28674 EFFECT OF RADIATION ON THE SUSCEPTIBILITY OF WHEAT SEEDLINGS TO LEAF RUST. II. CHANGES IN RUST SUSCEPTIBILITY DUE TO PARTIAL IRRADIATION OF WHEAT SEEDLINGS AND ITS DOSE DEPENDENCE. Katsuya, Keizo (National Inst. of Genetics, Misima, Japan). Nippon Shokubutsu Byori Gakkaiho, 28: 121-3(June 1963). (In Japanese).

The stems and leaves of seedlings of Triticum vulgare (Norin No. 16) were irradiated at the 2-leaf state by x rays at 5 KR. The seedlings were incubated 10 days after irradiation by spraying with an aqueous uredospore suspension of Puccinia triticina. The first leaves of the seedlings were removed 10 days after inoculation and the size of uredosori was measured. The size of uredosori on plants whose whole bodies or stems were irradiated was about 1.7 times larger than that on the control and the plants whose leaves only were irradiated. Seedlings of T. vulgare (Norin No. 50) at the second leaf stage were irradiated by ^{137}Cs γ rays at 0.1, 0.25, 0.5, 1, 2.5, 5, and 10 KR. The seedlings were inoculated 6 days after irradiation by spraying with the uredospore suspension. Seedling length was measured 7 days after irradiation, and the size of the sori was measured 12 days after inoculation. Inhibition of seedling growth increased with an increase of the dose, but there was no further decrease in the seedling lengths at doses above 1 KR. The size of the sori increased with an increase of the dose, but it did not increase further at doses above 5 KR. (BBB)

28675 A TECHNIQUE OF INVESTIGATING PRIMARY RADIATION EFFECTS IN BIOLOGICAL SYSTEMS. Dobretsova, T. B. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 12, Ser. Biol.-Med. Nauk, No. 3, 118-21(1966). (In Russian).

A glass irradiator is described for irradiating seeds with a variable moisture content under various gases at a pressure from a few ppM Hg mm std to normal atmospheric pressure. Two pumps are used to evacuate the system. Lyophilization (low-temperature drying) of biological material is carried out at 10^{-4} to 10^{-5} mm Hg std under high-purity gas. Two manifolds, each of which held five samples, are attached to the system. Pure oxygen is generated by heating $KMnO_4$. Seed moisture is controlled by drying over H_2SO_4 solutions (for moisture content up to 35%) or over P_2O_5 (for dry seed of 4 to 6% moisture). On admitting molecular oxygen into an evacuated ampoule containing irradiated wheat seeds, the electron paramagnetic spectrum (EPR) showed a wide line that belongs to free radicals that react readily with oxygen. At the same time the intensity of a narrow line increased due to the formation of an oxygen-containing free radical by the following reaction: $R^* + O_2 \rightarrow R^*O_2$. (TTT)

28676 ACTION OF ULTRAVIOLET RADIATION ON THE CHLORELLA UNDER CONDITIONS OF CONTINUOUS, INTENSIVE CULTIVATION. Rodicheva, E. K.; Gitel'zon, I. I.; Terskov, I. A. (Inst. of Physics, Krasnoyarsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 12, Ser. Biol.-Med. Nauk, No. 3, 33-7 (1966). (In Russian).

All previous studies on the effect of ultraviolet radiation on algae were carried out under artificial conditions; therefore, a constant cultivation method, developed by B. G. Kovrov et al., was chosen as an investigation of the growth behavior and productivity of Chlorella vulgaris. The culture, consisting of a suspension, was circulated by means of a centrifugal pump through the main container, past sensors that actuated the various control devices. A 6-kw lamp served as the light source for irradiating the 850 ± 50 cm^3 suspension, with a biomass concentration of 8 g/liter, at a rate of 140 ± 10 kerg/cm^2·sec, at 37 ± 0.5°C. The air supply, CO_2 content of the air and the feed were also kept constant. It was found that exposure to 24×10^9 erg induces irreversible changes in the biosynthesis, stopping the cell growth; at lower exposure levels, regeneration was noted. Changes of the chlorophyll content exhibited a similar, dose-dependent reversible or irreversible behavior. It was also found that the inhibiting action of the uv radiation is more strongly noted during less intensive growth periods. (TTT)

28677 EFFECT OF γ-RAYS ON PINE RESIN CHANNEL ANATOMICAL STRUCTURE AND PHYSIOLOGIC CONDITION. Lazda, E. E.; Odintsov, P. N. (Inst. of Wood Chemistry, Riga). Latv. PSR Zinat. Akad. Vestis, No. 1, 36-44(1967). (In Russian).

The effects of γ rays on the resin secretory system of forty-year pines were studied. Radiation doses of 31,000, 18,000, and 9000 R were used. Irradiation was effected through cobalt needles fixed around the tree trunk. The results of the study show that the biosynthesis of resin in epithelial cells begins at all irradiation doses. Resin flows from epithelial cells into nearest parenchymal cells and tracheids. As a result of irradiation, the anatomical structure of horizontal resin channels is modified. In parenchymal cells gamma-ray action causes a marked vacuolization, exfoliation of the cytoplasm, transformation of reserve substances and modification of the structure of nucleus. (auth)

28678 PLASMOLYSIS AND PERMEABILITY OF ALPHA-IRRADIATED EPIDERMAL CELLS OF ALLIUM CEPA L. Stadelmann, Eduard J. (Univ. of Minnesota, St. Paul); Wattendorff, Joachim. Protoplasma, 62: 86-116(1966).

The upper epidermis of the onion scale (A. cepa) was exposed to 7.4 to 13.9×10^8 α particles/mm^2 (0.8 to 1.5 Mrad). After irradiation, the epidermis was placed in a perfusion chamber. The proto-

plasts were plasmolyzed in 1M glucose solution and deplasmolyzed subsequently in 1M urea solution. Time-lapse photographs were used to measure changes in protoplast structure and size. During plasmolysis the first stages of separation of the contracting protoplast from the cell wall appeared earlier in irradiated than non-irradiated control cells. Irradiated cells showed, at the beginning plasmolysis, a more concave form than the controls, but this difference disappeared after 15 min of plasmolysis. An increase of the wall attachment presumably occurred. Swelling of protoplasm, similar to cap plasmolysis, and development of droplets with extraplasmatic fluid inside the vacuole were sometimes observed. No other significant difference in plasmolysis forms was found nor was the time of end plasmolysis changed in irradiated cells. Partial protoplasts were much more frequent in irradiated cells. Herniated protuberances were formed in irradiated cells and controls, caused by the progressive hardening of the external protoplasm layer after long preplasmolysis in glucose. Frequency was slightly greater for the controls. The osmotic value at incipient plasmolysis was slightly lower for irradiated cells. The plot of the protoplast length vs time, after an initial period of decreasing slope (for about 60 to 300 min), followed an inclined straight line, unchanged for many hours. Immediately before the cell died, increased speed of deplasmolysis was noted. No difference in permeability constants for urea (mostly between 1.6 and 3.6×10^{-8} cm sec^{-1}) between radiated sample and control cells was found. Full restoration of the cell permeability took place in the surviving cells when plasmolyzed about 5 hr after α irradiation. (BBB)

28679 DEVELOPMENT OF YEAST ON IRRADIATED PACIFIC CRAB MEAT. Eklund, M. W.; Spinelli, J.; Miyauchi, D.; Dassow, J. (Bureau of Commercial Fisheries, Seattle). J. Food Sci., 31: 424-31(May-June 1966).

This report describes the factors affecting growth of yeasts in irradiated crab meat; the genera of yeasts present on the unirradiated product and those surviving the irradiation treatment and growing on the refrigerated product; and the biochemical activities of the different genera that might be potentially deleterious to the product. King crab and Dungeness crab were irradiated with doses of 0.2 or 0.4 Mrad. Yeasts increased rapidly on air-packed irradiated samples of crab meat stored at 0.5 and 5.6°C. The growth of the yeasts on irradiated crab meat was inhibited by vacuum-packing the sample. No appreciable increase in yeast counts occurred on the unirradiated controls. A total of 569 yeast cultures were isolated from unirradiated and irradiated crab meat. The genera represented included Rhodotorula, Cryptococcus, Torulopsis, Candida, Trichosporon, and a yeastlike organism resembling Aureobasidium pullulans. Members of Cryptococcus, Candida, and A. pullulans were gelatinolytic and lipolytic. Trichosporon isolates were very active in attacking gelatin, casein, and triglycerides. The yeast populations were considerably higher on irradiated samples, probably because of elimination of bacteria which compete with yeasts for available nutrients. (BBB)

28680 STUDIES ON INDUCED MUTATIONS IN RICE. Miah, Abdul Jalil; Bhatti, I. M.; Ghafoor, A. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). Nucleus (Lahore), 3: 75-8(July-Sept. 1966).

Rice seeds of two local varieties were irradiated using a ^{60}Co source. After storing for one month, the irradiated seeds were planted. At maturity the plants were harvested separately and data were recorded on fertility of the ears. Seeds were collected and sown to raise the second generation. It was found that seed fertility decreased due to irradiation. It was evident that the Kangni-27 variety was more radioresistant than the Dokri Basmati variety. (H.L.W.)

28681 THE VALUES FOR THE STIMULATION EFFECTS OBTAINED BY γ IRRADIATION OF SEEDS OF TOMATO (LYCOPERSICUM EXCULENTUM L) VAR. PRIMABEL. Silvy, Andre (CEN, Cadarache, France). Compt. Rend., Ser. D, 264: 1653-6 (Mar. 20, 1967). (In French).

Irradiation before sowing with low γ doses causes stimulation effects observable only under very precise experimental conditions or during limited periods of the development. Equivalent effects are obtained by modifying secondary factors. (tr-auth)

28682 STUDIES ON THE MUTATION INDUCTION BY THE INTERNAL RADIATION OF β-EMITTING RADIOISOTOPES IN CROP PLANT. II. EFFECTS OF ^{32}P TREATMENT TO THE PHOSPHORUS DEFICIENT RICE SEED ON THE GROWTH AND MUTATION FREQUENCY. Onozawa, Yoshiro (Ibaraki Univ., Japan). Radioisotopes (Tokyo), 15: 335-9(Nov. 1966). (In Japanese).

Three kinds of rice seed that differed in phosphorus content were soaked in a ^{32}P solution for 14 days. The dose was 8 μCi/seed in all cases. Phosphorus-32 incorporation into the seeds was not influenced by initial seed content. Physiological damage was greatest in seedlings from seed with low P content, but reproductive integrity was not related to P content. Mutation rates were decreased by increase in P content, and the mutation spectrum varied significantly among the three types. (TSS)

28683 ROL MIKROELEMENTOV V PROTSESSE ROSTA I RAZVITIYA RASTENII. DOKLADY NAUCHNOI KONFERENTSII PRIBALTIISKIKH RESPUBLIK I BELORUSSII PO VOPROSAM ROSTA I RAZVITIYA VYSSHIKH RASTENII SOSTOYAVSHEISYA 25–29 IYUNYA 1963 g. (Role of Microelements in the Growth and Development Processes of Plants. Reports of the Scientific Conference of the Pre-Baltic Republics and Belorussia on the Problems of Cultivation and Development of High Plant Species, May 25–29, 1963). Bluzmanas, P. I.; Dagis, I. K. (eds.). Vilnyus, USSR, Izdatel'stvo Mintis, 1965. 130p.

Effects of macro- and microquantities of various minerals and elements on the growth and development of agricultural plants are discussed. A separate abstract has been prepared for one of the twenty-one chapters. (R.V.J.)

For an abstract of the individual chapter see: 28684.

28684 INFLUENCE OF RADIOACTIVE COBALT ON THE GROWTH AND DEVELOPMENT OF CORN. Kietse, V. T. pp 55-60 of Rol Mikroelementov v Protsesse Rosta i Razvitiya Rastenii. Bluzmanas, P. I.; Dagis, I. K. (eds.). Vilnyus, USSR, Izdatel'stvo Mintis, 1965. (In Russian).

The influence of radioactive cobalt on development and yield of corn was studied. Various doses of radiation were selected in order to speed up the ripening of ears and increase the green mass of the plant. (R.V.J.)

28685 NET RADIATION, VISIBLE RADIATION, APPARENT PHOTOSYNTHESIS, AND EVAPOTRANSPIRATION IN SOYBEAN CANOPIES. Singh, Maharaj. Urbana, Ill., Univ. of Illinois, 1966. 80p.

Thesis.

Vertical distribution of net radiation, apparent photosynthesis, and evapotranspiration were experimentally measured between July 11 and August 14, 1965 in the canopies of Wayne and Harosoy-63 varieties of soybeans planted in east-west rows at row spacings of 20-inches, 30-inches, and 40-inches. Net radiation was measured with miniature net radiometers over the crop, and in the top, middle and bottom regions of the canopy. The net radiometers in the canopy moved horizontally over a span of 10 cm while the net radiometer over the crop remained stationary. Distribution of visible radiation was determined from spectral intensity measurements with a spectroradiometer over the crop and at 25 cms. above ground in the canopy on August 12 to 14. Apparent photosynthesis was measured by the closed canopy technique. Carbon dioxide concentration was continuously monitored by an infrared analyzer which fed the signal to a CO_2 controller. The CO_2 controller operated a solenoid valve and a counting timer. The CO_2 was fed into the photosynthesis chamber from a pressure cylinder through the solenoid valve and an adjustable flow meter. The CO_2 controller was set to maintain CO_2 concentration in the photosynthesis chamber at 0.03%. Apparent photosynthesis was determined from the setting on the flow meter and the reading on the counting timer. The photosynthesis chamber was not sealed from the soil surface. Evapotranspiration was determined by collecting the water withdrawn by the air conditioner from the air in the photosynthesis chamber during cooling cycles. Percent net radiation decreased exponentially with depth in the upper half of the canopy with an extinction coefficient = 1.46 cm^{-1}. The rate of decrease was smaller in the lower half of the canopy. Row spacing showed no marked effect on the percent net radiation in the bottom region of the canopy. Net radiation in the bottom region of Wayne and Harosoy-63 canopies was ≃13% and ≃15% respectively of the net radiation over the crop. The vertical distribution of net radiation measured in the rows earlier in the season was nearly the same as measured in the inter-row of a fully developed canopy later in the season. The vertical distribution also did not show any large changes from 10:30 a.m. to 4:30 p.m. Only ≃2% of the visible radiation incident over the crop reached the bottom region of Wayne canopies. The corresponding figure for Harosoy-63 canopies was ≃4%. Row spacing did not markedly affect these values. Apparent photosynthesis and efficiency of energy conversion were higher in Wayne canopies than Harosoy-63 canopies. Planting in 30-inch and 20-inch rows increased apparent photosynthesis and improved the efficiency of energy conversion. In general, soybean canopies showed no marked light saturation near solar noon. The mean peak rate of apparent photosynthesis averaged over all spacings was 2.13 g CO_2/M^2 ground area/30 min in Wayne canopies, and 1.73 g CO_2/M^2 ground area/30 min in Harosoy-63 canopies. The corresponding energy efficiencies calculated on the basis of net radiation over the crop were 2.50% and 1.76% respectively. Evapotranspiration was not markedly affected by the variety or row spacing used. The mean rate between 2:00 to 5:00 p.m. was 218 c.c. H_2O/M^2 ground area/30 min. (Dissertation Abstr.)

Radiation Effects on Microorganisms

Refer also to abstracts 27995, 28335, 28390, and 28574.

28686 (ANL-Trans-475) EFFECTS OF GAMMA RAYS ON THE RIBONUCLEIC ACID AND PROTEIN CONTENT OF AMOEBA. Skreb, Yvette; Eger, Magda; Horvat, Durda. Translated by William Sluis (Argonne National Lab., Ill.), from Biochim. Biophys. Acta, 103: 180-2(1965). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Biochemical effects of γ irradiation were studied in amoebae (whole, anucleated or nucleated fragments) exposed to 100,000 R. Irradiation resulted in a significant reduction in the RNA content in whole amoebae and in anucleated fragments. Following the immediate reduction, levels of RNA remained the same in whole amoebae and nucleated fragments but continued to drop rapidly in anucleated fragments. A similar pattern was noted in protein content. However, reduction in protein levels did not occur until the second day postirradiation. Results are compared with those of similar experiments performed previously with uv. (H.G.D.)

28687 ON THE NEED OF A PRELIMINARY REVIVICATION FOR THE COUNTING OF ENTEROBACTERIACEAE IN DEHYDRATED FOODS, IRRADIATED OR NOT. Mossel, D. A. A.; Jongerius, E.; Koopman, M. J. (Institut Central de la Nutrition et de l'Alimentation TNO, Zeist, Netherlands). Ann. Inst. Pasteur, 16: 119-25(1965). (In French).

Over 100 samples of irradiated and nonirradiated dehydrated foods and feeds were examined for Enterobacteriaceae by currently used direct methods, employing selective media, and by the same methods after a preliminary resuscitation treatment. Four types of dehydrated foods were investigated: commercial samples; artificially inoculated foods, examined immediately after inoculation; the same after storage for varying periods of time at 19 ± 1°C; and materials irradiated with γ rays at subpasteurization levels (≤0.6 Mrad) so as to secure final values of viable Enterobacteriaceae at suitable levels for counting. Using the plating procedures described, commercially dried and stored egg products were the only commodities that showed a significant increase in Enterobacteriaceae counts by using resuscitation; there was a 1000-fold increase by spreading onto a rich infusion agar and subsequently replicating onto violet red-bile glucose agar instead of using violet red-bile directly. The results of the enrichment tests by the most probable number procedure are shown. A total of 21% of the samples demonstrated increased recovery of Enterobacteriaceae when subjected to a resuscitation treatment in infusion broth, prior to enrichment in brilliant green bile broth. A strikingly reduced recovery after resuscitation, compared to direct enrichment, was occasionally observed. This might be due partly to the elimination of some of the Enterobacteriaceae by competitive organisms during pre-enrichment in infusion broth. Another cause of this effect might have been a better recovery of some cells of Enterobacteriaceae which had suffered sublethal damage, when they were transferred to a growth-limiting medium; in a very rich medium, these cells might have become active too rapidly to recover from the damage, e.g., to a vital enzyme system. The irradiated dry products never gave consistently higher results after a resuscitation treatment. This confirms earlier observations on the absence of a consistent influence of the nature of the medium on the recovery of bacterial cells surviving irradiation. It is concluded that a nonselective resuscitation procedure should always be employed in conjunction with an enumeration in selective media of Enterobacteriaceae in dried products. Such a resuscitation step can only be omitted after its having been established that virtually the same count is generally obtained with the direct use of the selective liquid or solid medium. For this purpose a sufficient number of tests should be carried out with the specific food as it is usually processed, handled, and stored. (BBB)

28688 CYTOPLASMIC FACTOR IN THE RESISTANCE OF YEAST CELLS TO ACTIDIONE AND ITS RESPONSE TO UV IRRADIATION. Wilkie, D.; Lee, B. K. (London Univ.). Genetica, 36: 267-76(1965-6).

A relatively high proportion of the cells of a particular strain of Saccharomyces cerevisiae formed slow-growing colonies when plated on 0.5 ppM actidione-agar. The production of this class of resistant mutant, which was not observed in unrelated strains, depended on the presence of a nuclear gene, designated R. The slow-growing colony was comprised of both sensitive and resistant cells, i.e., resistant cells give rise to a varying proportion of daughter cells that were revertants to sensitivity during colony development. Resistance was generally stabilized and its transmission assured following a second exposure of resistant cells to the drug. Resistance of the stable mutant was inherited only by a small proportion of ascospores in crosses to sensitive strains but showed some features of Mendelian transmission in crosses to a different resistant strain. The uv-induction of the slow-growing mutant showed a different pattern from that of gene mutation although both categories have a nucleic acid action spectrum. Two alternative hypotheses are presented to explain the results, one in which control of resistance is vested in a mutating cytoplasmic genetic unit and another where resistance is dependent on the functional state of a nuclear gene. (BBB)

28689 EFFECT OF THE DOSE RATE OF ^{60}Co γ-RAYS ON THE SURVIVAL OF SOME DEMATIACEAE SPECIES. Zhdanova, N. N.; P'yankov, G. N. (Inst. of Microbiology and Virology, Kiev). Izv. Akad. Nauk SSSR, Ser. Biol., No. 3, 438-42(May-June 1967). (In Russian).

An unequal dependence of the survival of four Dematiaceae species on the dose rate of ^{60}Co gamma-rays was shown. The microorganisms were exposed to 300, 400, and 500,000 rad in an interval of 50 to 2540 rad/sec. When estimating the lethal dose of the Dematiaceae species, it is necessary to take into account the exposure duration since the dose level may vary with time. (auth)

28690 A WHITE SPORELESS MUTANT OF PENICILLIUM DIGITATUM OBTAINED AFTER IRRADIATION OF PENICILLIUM DIGITATUM SACC. Barkai-Golan, Rivka (Volcani Inst. of Agricultural Research, Rehovoth, Israel); Kahan, R. S.; Lattar, F. S. Israel J. Agr. Res., 16: 95-6(June 1966).

After irradiation of Penicillium digitatum with sublethal doses of ^{60}Co γ rays, a white, almost sporeless strain was obtained. The irradiation was carried out on an inoculum containing both hyphae and spores obtained from a 2-week-old colony of P. digitatum, the calculated absorbed dose being 191 Krad. After transfer to fresh nutrient agar at 25°C, the irradiated inoculum continued to grow but with greatly reduced power of spore formation. A marked difference was found between the sensitivity of the 2 strains to γ irradiation. The white mutant was much more sensitive to further irradiation; a dose of 140 Krad to its inoculum was lethal, while 210 Krad was sublethal for the inoculum of the normal strain. Furthermore, at the sublethal dose of 70 Krad, the incubation period of the mutant and its rate of development were retarded as compared with that of the parent strain under the same conditions. The mutant had the same capacity for utilization of sugars as normal P. digitatum. It did not differ in its utilization of sugars and its reaction to an antagonistic strain of Streptomyces. The white mutant retained its pathogenicity to citrus fruits, but its rate of development on the fruit at 8 to 17° was lower than that of the parent strain. (BBB)

28691 REACTIVATION AT LOW TEMPERATURES OF SABIN POLIOVIRUSES INACTIVATED BY ULTRAVIOLET LIGHT. Cajal, N.; Baba, Constanta; Botis, S.; Babos, Aurelia; Danielescu, Georgeta; Oprescu, Elena (Inst. of Inframicrobiology, Bucharest). Rev. Roum. Inframicrobiol., 2: 291-9(1965).

Sabin strains of attenuated polioviruses, inactivated by uv light, may reacquire their activity after being kept at rest for 3 to 13 months at low temperature (−15°C). This phenomenon of reactivation after uv-induced injury was more frequently encountered, under the experimental conditions used, with serologic type 3. Study of certain genetic markers of the viruses, which acquired virulence in comparison with those of the original viruses that were not inactivated indicated that the reactivated polioviruses may be considered as mutants (R. I a and R. III a). Reactivation of polioviruses after inactivation with uv light is explained by a double mechanism: reversibility of the alterations produced by uv irradiation at the level of the viral RNA, associated with genetic multiplicity reactivation. (BBB)

28692 COMPARATIVE STUDY OF THE BIOLOGICAL ACTIVITY OF ERGOCALCIFEROL AND IRRADIATED YEAST. Zirins, Fr. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis, No. 2, 109-12(1967). (In Latvian).

Ergocalciferol and irradiated yeast (Saccharomyces cerevisiae), when applied in doses of equal biological activity, have an identical antirachitic effect, protecting chickens from rickets against the background of rachitogenic diet. Irradiated yeast, apart from ergocalciferol, contains other biologically active substances which are formed as a result of ergosterol photobiochemical transformation. These biologically active substances, acting as growth stimulators, either intensify the biological activity of ergocalciferol or work independently from it. (auth)

28693 TRANSFECTION ENHANCEMENT BY ULTRAVIOLET IRRADIATION. Epstein, H. T. (Brandeis Univ., Waltham, Mass.). Biochem. Biophys. Res. Commun., 27: 258-62(Apr. 20, 1967).

Competent cells of Bacillus subtilis SB1 were exposed to various doses of uv radiation and immediately afterward, transfecting DNA was added. The DNA was prepared from B. subtilis-specific bacteriophage wild types and its mutant SP82. The transfected-plaque-forming-units (PFUs) increased rapidly with radiation dose and

reached a peak after 90 to 120 sec of uv irradiation (120 to 160 ergs/mm^2). The maximum increase in PFUs was by a factor of 50 over that obtained with nonirradiated cells. The DNA concentration dependence of the transfection was also altered by irradiation. The response of nonirradiated cells was at least third-power with respect to DNA concentration; irradiated cell response was much higher and approximately first-power. The survival of competent B. subtilis was similar to that of noncompetent cells; the uv radiation dose that gave an average of one cell-lethal-hit was 12 sec. Accordingly, peak transfection of irradiated cells occurred after 5 to 8 cell-lethal-hit. The number of survivors was quite similar to the number of successful transfections; an explanation is not given. (B.H.S.)

28694 UV STABILIZATION OF RESCUED POLIOVIRUS. **Tershak, Daniel R. (Pennsylvania State Univ., University Park). Biochem. Biophys. Res. Commun., 27: 189-94(Apr. 20, 1967).**

The development of rescued virus was monitored by testing for changes in uv sensitivity of virus synthesizing centers following infection. Guanidine-sensitive (GS) and guanidine-dependent (GD) strains of type 1 poliovirus and HeLa cells were used in the investigation. Guanidine inhibited the growth of GS virus; however, simultaneous infection with GD virus boosted the GS virus titer about 100 fold—about 2% of the GS virus yield in the absence of guanidine. Use of 100 μg/ml guanidine in the overlay caused inhibition of GS virus but increased the titer of GD virus and illustrated that that in a mixed infection, GS virus could be titrated free of GD virus by employing a normal overlay medium. About 98% of GS cell-free virus was inactivated by uv irradiation and afterwards, a more resistant population appeared. In the absence of guanidine a marked degree of uv stabilization was noticeable. The uv sensitivity of rescued virus after infection was analogous to the uv sensitivity of GS virus after infection in the absence of guanidine. At high multiplicity GS infected cells were more resistant to uv radiation than cells infected at low multiplicity in the presence of guanidine. However, the degree of uv resistance was not comparable to that of rescued virus or virus that developed in the absence of inhibitor. The degree of uv resistance under high multiplicity of infection was a maximum if it were assumed that GD virus could cross-reactivate GS virus as efficiently as GS virus could reactivate itself. Therefore, it appeared that the phenotypic products of GD virus enabled GS virus to replicate and establish radiation resistance, i.e., that the rescued virus underwent a normal process of uv stabilization that suggested replication of the incoming genome from GD virus. (B.H.S.)

28695 MULTI-SITE DAMAGE AND X-RAY-INDUCED LETHALITY IN YEAST. **James, Allen P.; Werner, Mary M. (Chalk River Nuclear Labs., Chalk River, Ont.). Can. J. Genet. Cytol., 9: 129-35(Mar, 1967).**

Evidence has been obtained that lethality induced by x-rays in yeast frequently requires the destruction of several intracellular sites. The study concerned the relationship between induced mitotic delay and the manner in which lethality is expressed. The interval between irradiation and first post-irradiation cell division varied for different manifestations of death. The mitotic delay increased in the order: 1) cells which survived only one or two divisions, 2) cells in which lethal damage was sufficiently latent to allow production of abortive colonies, 3) cells which produced sectored colonies, and 4) cells which showed no lethal effects. This positive correlation between induced mitotic delay and ability of cells to maintain post-irradiation cell division was interpreted as an indication that repair mechanisms influence the way in which death is manifested. The data suggested that differences in ability to maintain post-irradiation cell division reflect quantitative differences in extent of sustained damage, i.e., in number of affected sites. Mitotic delay increases the probability that all affected sites will be repaired, but partial repair (repair at a fraction of affected sites) only converts lethal damage of more immediate expression to that of less immediate expression. There was no evidence of repair of lethal damage after the first postirradiation cell division; greater mitotic delay in the interval between first and second divisions was accompanied by reduced ability to maintain further cell divisions. (auth)

28696 BIOLOGIC PROPERTIES OF ANAPLASMA MARGINALE: EFFECTS OF IONIZING RADIATION ON INFECTIVITY OF PARTIALLY PURIFIED MARGINAL BODY PREPARATIONS. **Wallace, W. R. (Northwestern State Coll. of Louisiana, Natchitoches); Dimopoullos, George T. Amer. J. Vet. Res., 26: 1356-8(Nov. 1965).**

Effects of ^{60}Co γ radiation on ability of partially purified Anaplasma bodies to infect splenectomized calves were studied. Infectivity of partially purified marginal body preparations was decreased at irradiation levels of 75,000 to 100,000 R. Suspensions of marginal bodies subjected to more than 100,000 R lost their ability to produce the disease in calves; however, these calves developed the disease when their susceptibility was challenged with untreated Anaplasma-infected blood. As the radiation dose was increased, the incubation period necessary for infection became longer; the calves were infected from the inoculations with irradiated marginal bodies. Aberrations in morphologic structure of the Anaplasma bodies or discrepancies in development of the disease were not apparent after marginal bodies appeared in the erythrocytes when calves were infected with irradiated material or in calves given a challenge dose of infected blood. This is the first report on the successful infection of bovine animals with the partially purified anaplasma body preparations. (BBB)

28697 VARIATION IN THE PHOTOCHEMICAL REACTIVITY OF THYMINE IN THE DNA OF B. SUBTILIS SPORES, VEGETATIVE CELLS, AND SPORES GERMINATED IN CHLORAMPHENICOL. **Smith, Kendric C.; Yoshikawa, Hiroshi (Stanford Univ., Palo Alto, Calif.). Photochem. Photobiol., 5: 777-86(Oct, 1966).**

The chief photoproduct of thymine produced in uv-irradiated (2537 Å) vegetative cells of Bacillus subtilis was the cyclobutane-type dimer while in spores very little of this dimer was produced (max yield 2.6% of thymine) but a new photoproduct was produced in high yield (max of 28.4% of thymine). This difference in response to uv radiation appeared to be due, at least in part, to a difference in hydration of the DNA. The photochemistry of thymine in isolated DNA uv irradiated in solution was similar to that of DNA in irradiated vegetative cells, but differed markedly from that of isolated DNA irradiated dry. The yield of cyclobutane-type thymine dimer was much reduced in isolated DNA irradiated dry but a new photoproduct of thymine was produced which was chromatographically similar to the spore photoproduct. The yield of this photoproduct, however, was never as great as that obtained in uv-irradiated spores. The photochemistry of the DNA thymine of spores germinated in the presence of chloramphenicol was similar to that of normal vegetative cells. Except for hydration, the physical state of the DNA was probably not otherwise altered by germination in the presence of chloramphenicol since DNA replication is prevented by the presence of chloramphenicol. These results were also consistent with the hypothesis that the unique photochemistry of spores depends on the hydration state of the DNA. Acid stability of the spore photoproduct was indicated by the fact that it was isolated from irradiated spores after hydrolysis in trifluoroacetic acid at 155°C for 60 min. It still contained the methyl group of thymine, as judged by the fact that for a given dose of uv the same yield of photoproduct was obtained whether the spores were labeled with thymine-2-^{14}C or -methyl^{14}C. This photoproduct was stable to uv reirradiation (2537 Å) in solution under conditions where thymine dimers of the cyclobutane-type were completely converted back to monomeric thymine. On a column of molecular sieve material (Sephadex G10), the spore photoproduct eluted in a region intermediate between the cyclobutane-type thymine dimers and monomeric thymine. Of the compounds tested by paper chromatography, the spore photoproduct was most similar (but not identical) in several solvents to 5-hydroxyuracil and 5-hydroxymethyluracil. Whether the product is a monomer or a dimer could not be ascertained. (BBB)

28698 SENSITIVITY OF E. COLI B TO IRRADIATION. VI. EFFECT OF CYSTEINE ON DNA BREAKDOWN BY IONIZING IRRADIATION. **Nagy, Zs.; Hernadi, F.; Kovacs, P. (Univ., Debrecen, Hung.). Acta Microbiol., Acad. Sci. Hung., 13: 21-4 (1966).**

The post irradiation effect of cysteine in the irradiation-induced DNA breakdown and colony-forming ability of E. coli B was examined. Three- to 15-kR doses of x rays were used. During 90-min incubation in acetate buffer, no change occurred in the number of viable cells and DNA content of nonirradiated bacteria. In the irradiated cultures, the DNA content decreased by 45% and the bacterial count fell from 10^7 to 10^3 per ml after the 15-kR dose. The degree of DNA breakdown could be modified by incubating the irradiated bacteria in the presence of cysteine at different concentrations. Since DNA breakdown was inhibited at high cysteine concentrations only (0.025 to 0.1 M), the phenomenon appears to be nonspecific and similar to that observed in concentrated solutions of various substances. Due to a dehydrating effect, the osmotic pressure of the medium influences the radiosensitivity of cells by altering enzymic reactions responsible for irradiation-induced DNA breakdown. No correlation was seen between DNA breakdown and the number of surviving cells. In experiments in which DNA breakdown was maximal during the 90-min incubation period, the viable cell count remained unchanged. When cysteine inhibited the breakdown of DNA, the viable count slightly increased. (BBB)

28699 PHOTOREVERSAL OF c-MUTATIONS INDUCED BY U.V. IN THE EXTRACELLULAR PHAGE KAPPA. **Kaplan, R. W. (Univ., Frankfurt am Main). pp 279-8 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.**

Photoreversal of c-mutations were detected in the extracellular phage kappa. Postillumination of the free uv-irradiated phage at a constant temperature of 30°C reduced the yield of c-mutations to about $^{2}/_{3}$ or $^{1}/_{2}$. Inactivation, on the other hand, was decreased only a few percent. Blue-violet light induced maximum reversal after a dosing time of 10 min; white light only after 60 min. The light-dose curve of the c-mutations initially fell linearly to a minimum of about half the original value after 10 min of illumination; it then went upward again, 60 min giving about the original value. When light was applied $^{1}/_{2}$ hr after infection of cells by the uv-treated phage, i.e., intracellularly, the mutation reversal was low but the survival after 4.5-min uv exposure increased strongly. This shows that the mutation reversal is not improved by the intracellular conditions but that the photoreactivation of killing is. Thus metabolism seems not to be necessary for reversal but is perhaps needed for reactivation. The increase of the mutation yield at high light doses by 2 possible causes is discussed. The lesions reversed (incompletely) by the light could be re-converted to mutative lesions by further absorption of light quanta; or certain lesions which do not give mutations under usual conditions could be changed by (several) light hits to mutative lesions. (BBB)

28700 SYNERGISTIC AGENTS FOR THE RADIATION INACTIVATION OF BACTERIA. Namiki, Mitsuo. Genshiryoku Kogyo, 11: 64-9(Jan. 1965). (In Japanese).

Investigations on the synergistic effects of halogen compounds and radiation for the inactivation of bacteria are described. From results of the study on the synergistic action of alkali halides, using the survival curve of E. coli as an indicator, it was found that this action is due to the presence of halogen ion and that the order of effectiveness is roughly $I^- \gg Br^- > Cl^-$. The action mechanism of halogen ions is considered to depend on the damage to parts other than the chromosome DNA, because they accelerate considerably the radiation decomposition of SH–compounds. It has recently been found that fluorine ion also has the same action, but it seems that the action mechanism differs from that of other halogen ions. Halogen phenols also have this action; the order of effectiveness is I > Br > Cl as a substituent and p- > m- > o- in the site substituted. Among other synergistic agents there are vitamin K, its derivative, Synkavite, and N–ethyl maleimide. These are also thought to react with SH-radicals. Iodoacetic acid amide and 5–bromuracil also have this action; the former is known to act on the cell membrane and the latter to cause damage to the DNA molecules and promote the lethal effect of radiation. The synergistic agents for the radiation inactivation of bacteria are applicable to food sterilization and to the radiotherapy of cancers when used as sensitizers. The study of the action mechanism of these agents is also important to make clear the biological effect of radiation, especially its lethal effect. (NSA of Japan)

28701 MICROFLORA IN RADIOTHERAPY IN PATIENTS WITH CANCER OF THE CERVIX UTERI. Sokolova, N. M.; Klechikov, L. Z.; Saridzhalinskaya, E. K. (Petrov Inst. of Oncology, Leningrad). Vop. Onkol., 13: 90-5(1967). (In Russian).

The total number of microorganisms decreased in all patients during the process of radiotherapy for cervical cancer. Occurrence of hemolytic cocci was inhibited by treatment, whereas non-hemolytic forms were more abundant after therapy. Radio-induced changes in microflora were accompanied by a reduction in antibiotic sensitivity. (auth)

28702 SURVIVAL OF POLIOVIRUS IN FLOWING TURBID SEAWATER TREATED WITH ULTRAVIOLET LIGHT. Hill, W. F. Jr.; Hamblet, F. E.; Akin, E. W. (Public Health Service, Dauphin Island, Ala.). Appl. Microbiol., 15: 533-6(May 1967).

The effectiveness of a model ultraviolet (uv) radiation unit for treating flowing turbid seawater contaminated with poliovirus was determined. At a turbidity of 70 ppm, the observed survival ratios ranged from 1.9×10^{-3} (99.81% reduction) to 1.5×10^{-4} (99.98% reduction) at flow rates ranging from 25 to 15 liters/min; no virus was recovered at flow rates of 10 and 5 liters/min. At a turbidity of 240 ppm, the observed survival ratios ranged from 3.2×10^{-2} (96.80% reduction) to 2.1×10^{-4} (99.98% reduction) at flow rates ranging from 25 to 5 liters/min. As expected, turbidity had an adverse influence on the effectiveness of uv radiation; however, by adjusting the flow rate of the seawater through the treatment unit, adequate disinfection was shown to be predictable. (auth)

28703 EFFECT OF FOOD ADDITIVES AND IRRADIATION ON SURVIVAL OF SALMONELLA IN OYSTERS. Shiflett, Maureen A.; Lee, J. S.; Sinnhuber, R. O. (Oregon State Univ., Corvallis). Appl. Microbiol., 15: 476-9(May 1967).

Salmonella typhimurium and S. enteritidis were inoculated into blended oysters, both raw and autoclaved. The oysters were also treated with sodium benzoate (0.1%) or potassium sorbate (0.1%), and irradiated (0.1 Mrad). In both nonirradiated and irradiated samples, greater numbers of Salmonella were recovered after storage at 7 C° in the presence of sodium benzoate or potassium sorbate. The results of the autoclaved samples and studies in buffer indicated that this effect was not due to the reduction of competition from the natural flora when the additives were present. (auth)

28704 IRRADIATION OF COMPOSTS USED IN PROPAGATION OF AGARICUS BISPORUS. Splittstoesser, D. F.; Massey, L. M. Jr. (New York State Agricultural Experimental Station, Geneva, N. Y.). Appl. Microbiol., 15: 646-9(May 1967).

Unpasteurized horse manure composts were given radiation doses of 0.1 and 1.0 Mrad in an attempt to increase mushroom yields by eliminating competing microorganisms. Yields were enhanced by 0.1 Mrad but were lower than those obtained with heat-pasteurized composts. Composts subjected to 1.0 Mrad gave the lowest yields, probably because of the generation of ammonia and other toxic compounds. Only temporary changes in the predominant microflora could be detected as a result of ionizing radiations. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 28687 and 28703.

28705 IRRADIATION OF POULTRY AND EGG PRODUCTS AS SUPPLEMENT TO FREEZING. Boersma, H. Y. (Instituut voor de Pluimveeteelt "Het Spelderholt," Beekbergen, Netherlands). Conserva (The Hague), 15: 18-19(July 1966). (In Dutch).

Use of ionizing radiation for sterilization or pasteurization of poultry products, along with other preservation methods, is examined. For poultry the results obtained with radiation pasteurization have been encouraging, in comparison with other meat products. The use of irradiation combined with cold storage seems promising. Treatment with sterilizing doses (~4.5 Mrad) fails to inactivate enzymes, which lead to deterioration of flesh, when storage is not at low temperatures. Possibilities of using heat treatment with irradiation are considered. Radiopasteurization is accomplished with doses of 0.4 to 0.5 Mrad, which markedly lower the Salmonella count. For radiation processing of eggs, prior freezing is essential. Similar pasteurization doses (~0.5 Mrad) are successful in reducing the Salmonella count of frozen egg products. Comparisons are made with heat treatment. There is evidence that radiopasteurization may be of real value in preservation of frozen egg. (BBB)

28706 EFFECTS OF STORAGE TEMPERATURES AND IRRADIATION ON THE QUALITY OF FLORIDA-90 STRAWBERRIES. Kuhn, G. D.; Merkley, Margaret S. (Florida Agricultural Experiment Station, Gainesville). Proc. Fla. State Hort. Soc., 1965, 78: 296-302(1966).

Cobalt-60 γ radiation levels of 200 and 3000 Krad reduced decay incidence in berries stored at 35° and 50°F. However, at 35°F storage, irradiation was largely ineffective in controlling the loss of marketable berries to any greater extent than could be achieved by low temperature alone. Incidence of soft fruit was considerably higher in berries given 200- and 300-Krad doses. Cooling fruit immediately following harvest greatly reduced the number of decayed berries. During the first three days postirradiation the percentage of marketable fruit was higher when berries were irradiated. Eight days after irradiation, all control berries were decayed; 61, 67, and 73% of the fruit in 100-, 200-, and 300-Krad treatments were still marketable. Ten days after irradiation, only the 200- and 300-Krad treatments contained any marketable fruit (22 and 75%, respectively). Until 10 days postirradiation, the incidence of soft berries was about the same in all treatments containing marketable berries. Taste panels found considerable variability among the fruit; no off-flavor or other undesirable effects were detected by flavor analyses of the irradiated fruit. (BBB)

28707 OBSERVATIONS ON RADIO-PASTEURIZED MEATS AFTER 12 YEARS OF STORAGE AT REFRIGERATOR TEMPERATURES ABOVE FREEZING. Licciardello, J. J.; Nickerson, J. T. R.; Goldblith, S. A. (Massachusetts Inst. of Tech., Cambridge). Food Technol., 20: 138(Sept. 1966).

Storage characteristics of irradiated beefsteak, hamburger, and pork sausage, stored at refrigerator temperatures above freezing (36 to 40°F), were determined. The beefsteak had been injected with an aqueous solution of sodium fumarate and monosodium glutamate to aid in reducing the irradiation off-flavor. The beefsteak was air-packed, and the hamburger and sausage vacuum-packed, in enameled cans which were irradiated by crossfiring with a dose of 10^6 rep (1.08 Mrad) with a 3-MeV Van de Graaff accelerator. The appearance of the various meat samples after 12 yr of storage was excellent. A slight irradiation odor was perceptible, but was not objectionable. A bacterial assay for total aerobes and total anaerobes indicated that the irradiated meats

were commercially sterile. Considerable proteolytic enzyme action was shown by a rise in the free amino nitrogen content of the irradiated beefsteak and hamburger. When cooked, all three meats had a sharp, bitter aftertaste, however, which made them unacceptable from a flavor standpoint. The flavor of both beefsteak and hamburger was reminiscent of liver. The bitter flavor was not detected in raw irradiated meats, but only in the cooked irradiated meats. It may be that the bitterness develops during the cooking process as a result of the free amino acids participating in a non-enzymatic browning reaction. The sharp taste was not due to a change in the pH of the meat. Thus, for a long-term storage, in excess of 6 months, of radiopasteurized meats at refrigerator temperature above freezing, the proteolytic enzymes must be inactivated. (BBB)

28708 SOME EFFECTS OF GAMMA RADIATION ON SEVERAL VARIETIES OF TASMANIAN POTATOES. II. BIOCHEMICAL CHANGES. Wills, Pamela A. Austral. J. Exper. Agr. Animal Husbandry, 5: 289-95(1965).

Tasmanian Up-to-date, Kennebec, Sebago, and Sequoia tubers were treated with low doses of gamma radiation to inhibit sprouting and were subsequently stored at 68°F or 45°F. Tubers were examined at bi-monthly intervals for some, or all, of the following biochemical constituents: dry matter, thiamine, reduced ascorbic acid, dehydroascorbic acid, total ascorbic acid, soluble reducing sugars, sucrose, total sugars, and starch. Radiation, independent of dose level, led to lower dry matter contents in the Up-to-date, Kennebec, and Sequoia tubers after four months storage, and in the Sebago tubers after six months storage at 68°F, but not at 45°F, when compared to the controls. The thiamine content of Up-to-date tubers was not influenced by radiation (16,000 R). Storage was a more important factor than radiation in altering the ascorbic acid content of tubers. Radiation maintained, or even increased the normal level. Radiation increased the soluble reducing sugar content of Sequoia tubers, the total sugar of Sequoia and Sebago tubers, and the sucrose content of the Sebago tubers, but had little effect on the starch content of these varieties. Storage influenced some of these constituents, particularly in the Sebago variety. (auth)

28709 EXPERIMENTS ON HOUSE FLIES STERILIZED WITH X RAYS. Sacca, Giuseppi (Istituto Superiore di Sanita, Rome). Atti Accad. Naz. Ital. Entomol., Rend. (1960), 8: 91-8(1961). (In Italian).

The experiments described were based on the previously demonstrated successful series of eradication of Callitroga hominivorax from Curaçao by release into the field of males sterilized by γ rays. Positive results were obtained mainly because of the monogamous habit of the flies. Preliminary experiments indicated that the females of Musca domestica are likewise usually monogamous. On this basis, attempts were made at sterilization of the adults by irradiating pupae with a dose of 3000 R x radiation 2 to 3 days before emergence. Flies which emerged from pupae after such irradiation were almost normal with respect to viability, longevity, and sexual activity, but were completely sterile. It was shown that normal females, previously mated with irradiated males, remated with normal males in only a small percentage of cases, but with somewhat higher rate than in the controls. Sterile males were able to compete with normal males for females, and, when present in overwhelming number, mated with most of the females, leaving them sterile. (BBB)

28710 RADIATION STERILIZATION IN MEDICINE: PRESENT APPLICATIONS AND FUTURE PROSPECTS. Antoni, F. (International Atomic Energy Agency, Vienna); Kozinets, G.; Koeteles, G. At. Energy Rev., 4: No. 3, 39-61(1966). (In Russian).

An attempt was made to summarize all the available data on the utilization of ionizing radiation for the sterilization of medical supplies. It is shown that radiosterilization of medical instruments and bandages is of definite practical use. Future uses of ionizing radiation for sterilization of biological tissues, synthetic materials, and various medications which cannot be subjected to chemical or thermal sterilization are discussed. (178 references.) (tr-auth)

28711 USDA RESEARCH PROGRAM AND FACILITIES FOR THE USE OF GAMMA IRRADIATION IN THE CONTROL OF STORED-PRODUCTS INSECTS. Laudani, H.; Tilton, E. W. (Stored-Product Insects Research and Development Lab., Savannah, Ga.). New York, American Institute of Chemical Engineers, 1966, Preprint No. 34C, 19p., $0.50. (CONF-660903-3). DTIE.

From American Inst. of Chemical Engineers Meeting, Atlantic City.

Protective treatments for prevention of insect infestations in stored grains are discussed in relation to cost of the treatment, development of insect resistance to the treatment, effects of the treatment on the grain, and toxicity of the treatment for man. The advantages of γ irradiation for controlling insects in grains are also discussed. Studies involving the γ radiosensitivity of the four metamorphic stages (egg, larva, pupa and adult) were conducted on the following species: Angoumois grain moth, Sitotroga cerealella; black carpet beetle, Attagenus piceus; cigarette beetle, Lasioderma serricorne; confused flour beetle, Tribolium confusum; Indian-meal moth, Plodia interpunctella; lesser grain borer, Rhyzopertha dominica; merchant grain beetle, Oryzaephilus mercator; red flour beetle, Tribolium castaneum; rice weevil, Sitophilus oryzae; saw-toothed grain beetle, Oryzaephilus surinamensis; the grain mite, Acarus siro; and the grain beetles Trogoderma glabrum and Trogoderma inclusum. In general, the egg was the most susceptible, next the larvae, then the pupae or hypopus; the adult was the least susceptible. The beetle species used in the tests were more susceptible to the γ radiation than the moths. Dosages below 50 krad were thought to be effective enough for elimination of grain insect infestations. A description of the grain irradiation facility and its operational procedure is given. In addition to bulk grain irradiation, the design provided for γ irradiation of a variety of packaged products in paper cartons, paper and textile bags, and shipping cases. A discussion on the applied and basic research that is to be conducted with the new facility is presented. (B.H.S.)

28712 WHOLESOMENESS TESTING OF IRRADIATED FOODS. Raica, N. Jr. (Fitzsimmons General Hospital, Denver). New York, American Institute of Chemical Engineers, 1966, Preprint No. 34A, 11p., $0.50. (CONF-660903-5). DTIE.

From American Inst. of Chemical Engineers Meeting, Atlantic City.

Twenty-one foods such as meats, fish, fruits, and vegetables irradiated to 5.58 Mrads and fed to dogs, mice, monkeys, and rats for two years were found to be as wholesome as nonirradiated foods. The foods were fed as single components comprising 70% of the dietary solids, or as five to nine components comprising 100% of the dietary solids. Over 300 dogs, 15,000 mice, 37 monkeys, and 10,000 rats were used in the studies. Criteria used in the evaluation of the wholesomeness of irradiated foods are outlined. (B.H.S.)

28713 THE ENTOMOLOGY OF RADIATION DISINFESTATION OF GRAIN. A Collection of Original Research Papers. Cornwell, P. B. (ed.). New York, Pergamon Press, 1966, 255p.

Original findings from entomological studies carried out to determine the value of the use of ionizing radiations for disinfestation of grain are presented. The reports contain information on susceptibility of the grain and rice weevils Sitophilus granarius (L.) and S. zeamais Mots. to γ radiation; susceptibility of laboratory and wild strains of the grain weevil S. granarius (L.) to γ radiation; the influence of temperature on the radiation susceptibility of S. granarius (L.); effects of continuous and fractionated doses of γ radiation on the survival and fertility of S. granarius (L.); the effect of culture environment on the susceptibility of S. granarius (L.) to γ radiation; control of S. granarius (L.) populations with sterilizing and substerilizing doses of γ radiation; the effect of rearing medium on the susceptibility of S. granarius (L.) and Tribolium confusum Duv. to γ radiation; susceptibility of T. castaneum (Herbst.) and T. confusum Duv. to γ radiation; susceptibility of Oryzaephilus surinamensis (L.) to γ radiation; susceptibility of Australian strains of Sitophilus and Tribolium species to γ radiation; effects of γ radiation on Rhizopertha dominica (F.), Cadra cautella (wlk.), Plodia interpunctella (Hübn.), and Lassioderma serricorne (F.); a comparison of susceptibility of S. granarius to accelerated electrons and ^{60}Co γ radiation; and the effect of dose rate on the responses of O. surinamensis (L.), S. granarius (L.), and T. confusum Duv. to ^{60}Co γ radiation. A discussion and review of the information in international literature on the cost of conventional insect control methods as compared to irradiation treatment; design principles of radiation desinfestation of plants; effects of ionizing radiation on the manufacturing properties, taste, and wholesomeness of the grain; and the engineering aspects of grain handling is also included. (B.H.S.)

28714 BELGIUM CONTRIBUTIONS TO THE DATA ON IRRADIATION OF SUBSTANCES. De Proost, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). 6p. (In French). (CONF-650581-1). DTIE.

From 2nd International Symposium on Applications of Nuclear Science in Agronomy and Veterinary Medicine, Ghent.

A brief review of the research projects in Belgium concerned with the effects of γ radiation on germination of potatoes; preservation of carrots, cherries, pears, strawberries, wheat, wheat flour, and white vegetables; metamorphic stages of the grain and rice weevils, Sitophilus granarius L. and Sitophilus oryzae L., the Mediterranean flour moth, Anagasta kühniella, and the white bean infesting beetle, Ancanthoselides obtectus; and the sterility of white vegetables experimentally contaminated with Clostridium sporogenes is presented. Studies on the genetic risks involved in con-

sumption of γ-irradiated foods are also briefly outlined. Descriptions of the ^{60}Co γ-irradiation facilities that were used in the projects are given. (B.H.S.)

28715 APPRAISAL OF SOME FOOD PROCESSING METHODS OF THE FUTURE. Bird, Kermit (Dept. of Agriculture, Washington, D. C.). 17p. (CONF-660827-1). DTIE.

From 7th International Congress on Nutrition, Hamburg.

Methods for food preservation are evaluated with emphasis on dehydration, freeze-concentration, compaction, canning, irradiation, and freezing. Radiation source and dose rate are tabulated for foods approved or having pending approval by the Food and Drug Administration in 1966. (H.G.D.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

28716 (BNL–50048) HIGH-TEMPERATURE LIQUID–METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 5, Number 1. (Brookhaven National Lab., Upton, N. Y.). Feb. 1967. 62p. Dep. CFSTI.

Reviews are presented of 21 technical reports which cover the following topics: thermophysical properties, bearings and seals, boiling, alkali metals, mercury, equipment, corrosion, and heat transfer. (D.L.C.)

Corrosion and Erosion

Refer also to abstracts 28730, 28751, and 28798.

28717 (BNL–11265) THE U.S. PROGRAM ON CORROSION BY LIQUID Na. Weeks, John R. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information of a preliminary nature on research programs conducted at three U. S. laboratories on corrosion of metals and alloys by liquid Na are given. Results of previous programs have been presented elsewhere and the current report discusses primarily the direction of effort in the U.S. (P.G.C.)

28718 (GEAP–4439) SODIUM MASS TRANSFER. XII. 1963 TEST RUN REPORTS, JULY–DECEMBER. Lockhart, R. W. (comp.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1964. Contract AT(04-3)-189. 170p. Dep. CFSTI.

Mass transfer effects in Na were investigated utilizing three prospective steel construction materials for a Na-cooled reactor system. Corrosion data and exposure effects are obtained by subjecting metallic samples, during programmed test runs, to flowing Na in test loops fabricated with various combinations of these materials. The materials tested are AISI type 316 stainless steel, Cr–Mo steel, and Cr–Mo–Ti steel. Data are presented in tables and graphs. (M.C.G.)

28719 (GEAP–5047) EFFECTS OF IMPURITY ADDITIONS ON THE INTERGRANULAR CORROSION OF HIGH PURITY Fe–Cr–Ni AUSTENITIC ALLOYS. Armijo, J. S. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Oct. 1966. Contract AT(04-3)-189. 20p. (EURAEC–1855). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The effects of alloying additions on the intergranular corrosion of nonsensitized austenitic alloys in boiling HNO_3–dichromate solutions have been determined. Controlled additions of C, N, O, Mn, S, Si, and P to a high purity 14% Cr, 14% Ni, bal Fe alloy and subsequent corrosion tests in boiling $5\underline{N}$ HNO_3–$0.46\underline{N}$ Cr^{+6} solutions showed that only Si and P promote intergranular corrosion susceptibility of nonsensitized alloys. Elimination of Si and P from austenitic alloys of otherwise commercial purity eliminates susceptibility to intergranular attack. (auth)

28720 (IN–1089) PERFORMANCE OF TYPES 304, 316, AND 348 STAINLESS STEEL IN NaK AT HIGH TEMPERATURES. Hoffman, T. L. (Idaho Nuclear Corp., Idaho Falls). May 1967. Contract AT(10-1)-1230. 11p. Dep. CFSTI.

A service test examination has been made on a welded assembly containing Types 304, 316, and 348 stainless steel. This assembly had been in NaK service for 14,200 hours at about 1000°F with the maximum temperature being 1400°F. There was no general corrosion damage on the materials. Appreciable carbide precipitation at the grain boundaries and sigma phase were observed in the Types 304 and 348 stainless steel, but only carbide precipitation in Type 316. These observations plus the results of additional evaluations indicate that the three steels are equally suitable from a corrosion standpoint for service in NaK in the temperature range and for the period reported. Although significant changes were detected in the structure of the alloys, none of these suggested failure in the absence of other factors. (auth)

28721 (NP–16413) THE CORROSION BEHAVIOUR OF STEELS AND NICKEL ALLOYS IN HIGH TEMPERATURE SODIUM. Thorley, A. W.; Tyzack, C. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). [1966]. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The salient features of studies on corrosion of stainless steels and Ni alloys by liquid Na are reported. Topics covered include mass-transfer by solution or oxidation processes at various temperatures and velocities, effect of loss of metal section and C pick-up upon mechanical properties, and effect of imposed stresses on clad material in a corrosive and carburizing environment. Evaluations are made on the behavior of brazing alloys in both static and dynamic liquid Na. Results of tests on six stainless steels and six Ni alloys at different temperatures and O_2 levels are tabulated. The effects of the velocity of liquid Na on various stainless steels and on Nimonic 80A are shown by diagrams. (P.G.C.)

28722 COMPARISON OF HYDROGEN AND DEUTERIUM SOLUBILITY IN PALLADIUM-RICH ALLOYS. GOLD–PALLADIUM. Maeland, Arnulf; Flanagan, Ted B. (Univ. of Vermont, Burlington). J. Phys. Chem., 71: 1950-2(May 1967).

The absorption of deuterium by a series of Au–Pd alloys was examined and compared with literature data for H_2 in Au–Pd alloys. Little difference was found in the equilibrium solubilities of the two isotopes even in alloys that did not form two phases (Au ≥ 17 atomic%). This behavior was in marked contrast to the behavior of Pt–Pd alloys. X-ray powder patterns were taken in the two-phase region of the D–Au–Pd system and were very similar to those observed for the corresponding alloys containing H_2. Thermodynamics parameters of the D–Au–Pd and H–Au–Pd systems in the two phase regions are given. The free energy and enthalpy changes corresponding to absorption in the two phase region became more negative with increasing Au content for both H_2 and deuterium. From the absorption characteristics of H_2 by Pd-rich alloys, the alloys can be grouped in two broad classes: group I alloys (I = increase) is designated as those in which the free energy for absorption into the two-phase region becomes more negative as the added metal content of the alloy is increased. Group I includes to date Ag–Pd, Au–Pd, Sn–Pd, and Pb–Pd. The other group designated as group D alloys (D = decrease) are characterized by the opposite behavior (the negative free energy decreases with added metal content). Group D alloys include Pt–Pd, Rh–Pd, Ni–Pd, Ir–Pd, and Cu–Pd. It can be predicted that for group I alloys there will be no significant difference in the isotopic solubilities of pure H_2 and pure deuterium. For group D alloys large differences in the solubilities at certain added-metal contents may be anticipated. (D.H.M.)

28723 OXIDATION OF Mg AND Mg–Be ALLOYS IN MOIST AIR AND WATER VAPOR AT HIGH TEMPERATURES. Zelenskii, V. F.; Petel'guzov, I. A.; Kolomiets, L. D. (Physical-Technical Inst., Kharkov). Zh. Prikl. Khim., 40: 1013-18(May 1967). (In Russian).

Investigations of oxidation of Mg–Be alloys in moist air and water vapor at 520 to 580°C showed that the alloys formed protective oxidation films at an oxidation rate approximately described by the parabolic law. An intensive hydrogenation taking place during oxidation and the molecular H_2 segregated in the internal defects of the alloys induced porosity and caused disintegration of the specimens. (R.V.J.)

28724 AN OXIDATION STUDY OF Ni–Cr–Fe ALLOYS IN CARBON DIOXIDE AT 800 TO 1000°C. Francis, J. M.; Jutson, J. A.; Buddery, J. H. (Central Electricity Generating Board, Berkeley, Eng.). J. Mater. Sci., 2: 78-87(1967).

A structural evaluation was made of thin oxide films formed on Hastelloy X and Inconel 600, under representative reactor conditions, with emphasis on the application of electron and x-ray-diffraction techniques for the identification of multicomponent surface oxide phases. The difficulties and limitations of these techniques in relation to the complexity of the oxide under examination are apparent, but nevertheless the large amount of useful information obtained has enabled some understanding of the oxidation mechanism. As in the case of highly alloyed Cr–Ni steels, the rate-determining step in the growth of surface oxide on both alloys appears to be cation diffusion through an initially formed chromic oxide phase, resulting in the subsequent development of an outer spinel oxide of variable composition. (P.C.H.)

28725 ELECTRON MICROSCOPE OBSERVATIONS ON THE OXIDATION OF ZIRCONIUM. A CONTRIBUTION TO THE CUBIC KINETIC THEORY. Gondi, P.; Missiroli, G. F. (Univ., Bologna. CNR, Bologna). Nuovo Cim. (10), 48B: 223-36(Apr. 11, 1967).

Structural observations have been carried out, mostly by transmission electron microscopy, for a study on the oxidation characteristics of Zr. At the initial stage of the oxidation at 400°C and for oxidations at 800°C there appear moiré patterns which have been referred to the O-saturated layer occurring on Zr. The presence of cubic ZrO_2 has always been ascertained in the oxide films. Up to thicknesses ≈4000 Å the oxide films show an epitaxial structure with subgrains corresponding to average distances of 550 Å; no

dependence of these on the film thickness has been experienced. The cubic oxidation law of Zr is explained in terms of lattice defects acting as anion vacancy sinks in the oxide film. With their density, the same lattice defects can also explain the low-temperature H permeability stage through the oxide film. (auth)

28726 ADSORPTION ON NIOBIUM(110), TANTALUM(110), AND VANADIUM(110) SURFACES. Haas, T. W. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Jackson, A. G.; Hooker, M. P. J. Chem. Phys., 46: 3025-33(Apr. 15, 1967).

Clean surfaces of Nb(110), Ta(110), and V(110) have been prepared by heating in an ultrahigh-vacuum environment. Low-energy, electron-diffraction measurements indicated that all clean surfaces were the same as an ideal (110) plane in the bulk to within experimental error. Adsorption of CO and O_2 on the clean surfaces of these metals led to similar patterns suggesting that the same structures formed on all three metals. The patterns obtained from adsorption of CO followed by warming to about 400°C were the same as those obtained by room-temperature exposure to O_2. This suggests decomposition of the adsorbed CO. At least three different structures of O_2 on these metals are produced as coverage is increased. Unfortunately, dissolution of the O_2 into the bulk prevents accurate determination of surface coverage and this, coupled with the inability to handle intensity-distribution curves effectively, has made complete structure determinations of these oxides impossible. (auth)

28727 INCREASING THE OXIDATION RESISTANCE OF NIOBIUM AT HIGH TEMPERATURES. Nedyukha, I. M.; Chernyi, V. G. (Inst. of Casting Problems, Kiev. Inst. of Electric Welding, Kiev). Fiz.-Khim. Mekh. Mater., 2: 646-8 (1966). (In Russian).

Cast binary Nb–Fe alloys containing 15 to 33% Fe and additionally alloyed with Ti, V, W, Cr, Al, and Ni, and ternary Nb–25% Fe–(5 to 20)% W, V, or Ti alloys were arc-melted from 99.4 to 99.99% pure materials and tested for oxidation resistance in air at 1200°C for 5 hr. Additions of Fe were found to increase the oxidation resistance of all the investigated Nb–Fe alloys, particularly at Fe concentrations of 25% or higher, which corresponded to the existence of the pure η-phase (Nb_2Fe_3) with a carbide-type structure. Alloys with less than 25% Fe had a significantly lower resistance, which, however, was many times higher than that of pure Nb. Of all the investigated alloying elements, Ti was the most effective in increasing the oxidation resistance of the ternary alloys. Nb–25% Fe–25% Ti alloy had the highest oxidation resistance: the absolute oxidation rate in 1-hr exposure at 1200°C was about 4 $mg/cm^2 \cdot hr$. In contrast, small additions of up to 5% Ti or up to 10% V only slightly increased the oxidation resistance of Nb–25% Fe alloys, while larger additions greatly decreased it. A partial substitution of Ti by alloying Nb–25%, Fe–25% Ti with Cr and V or with Ni and Al brought about no increase in the oxidation resistance of the alloy. An Nb–25% Fe alloy had a modulus of elasticity of 17,620 kg/mm^2 and an HV hardness of 710 kg/mm^2 compared with 10,650 and 145 kg/mm^2 for pure Nb; the Nb–25%, Fe–25% Ti alloy has a Poisson ratio of 0.34. (ATD)

Preparation and Fabrication

Refer also to abstracts 28794 and 28798.

28728 (BNWL-422) MAGNETIC FORCE WELDING APPLICATIONS AT BATTELLE NORTHWEST. Boolen, R. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

The use of magnetic force welding for materials in the ferrous, Ni-base, reactive, and refractory metal categories is discussed. Graphite was also successfully welded by the process. A partial list of the materials that have been studied is given. The microstructures of cross sectional weld areas in a representative selection of the listed materials are illustrated. The potential of magnetic force welding is also discussed. (P.C.H.)

28729 (BNWL-CC-236) FABRICATION HISTORY OF ALLOYS USED IN THE IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS PROGRAM. Claudson, T. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1965. Contract AT(45-1)-1830. 140p. Dep. CFSTI.

Procurement procedures and fabrication histories of several reactor materials are given. The fabrication history, chemical analysis, and mechanical properties of the materials are summarized according to class of material: pressure vessel steels, austenitic stainless steels, ferritic stainless steel alloys, austenitic-martensitic stainless steels, nickel–base alloys, iron-base super alloys, and zirconium alloys. (M.C.G.)

28730 (GEMP-475A) HIGH-TEMPERATURE MATERIALS PROGRAMS. PART A. Annual Report No. 6, January 31, 1966–January 31, 1967. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Mar. 31, 1967. Contract AT(40-1)-2847. 300p. Dep. CFSTI.

Developments are reported for studies on: mechanical and physical properties of high-temperature reactor materials; radiation effects on fast reactor cladding and structural materials; fabrication of refractory metal alloys; physical metallurgy of refractory metal alloys; fabrication of advanced long-life reactor fuel cladding and structural materials; physico-chemical properties of Fe–Cr–Al clad fuel systems; radiation effects on heat-resistant metals and alloys; plastic fatigue properties of heat resistant alloys; advanced pressure vessel materials; physico-chemical properties of clad UO_2 in potential meltdown environments; preparation and properties of high-temperature thermocouple and electrical materials; high-temperature carbides for fuel and structural applications; and radiation effects on BeO. (P.C.H.)

28731 (IS-RD-9) REACTOR MATERIALS DEVELOPMENT QUARTERLY [REPORT], JANUARY–MARCH 1967. Voigt, A. F. (ed.) (Ames Lab., Iowa). 26p. Dep. CFSTI.

Developments are reported for studies on: metal preparation and purification for Th, Y, and other reactor metals; phase diagrams for rare earth, refractory metal, and other reactor materials systems; mechanical behavior and forming of reactor materials; methods for single crystal preparation; and properties of materials at high temperature. (P.C.H.)

28732 (RMI-8) ANNUAL PROGRESS SUMMARY [ON URANIUM FABRICATION], 1966. (Reactive Metals, Inc., Ashtabula, Ohio). Apr. 20, 1967. Contract AT(30-1)-1405. 100p. Dep. CFSTI.

Progress is reported on upset-forging of NPR-NOE billets, precision extrusion of U, heating salt evaluation, small-hole tube feasibility study, ultrasonic measurements investigations, and plant assistance projects. (M.C.G.)

28733 STAINLESS STEEL FUEL PIN CLADDING. Nucl. Eng., 12: 453-4(June 1967).

A review is presented of experience gained in the production of drawn tubes to the high standard of quality necessary. Design considerations are discussed. (UK)

28734 FINNED TUBES. Wright, R. (Tube Investments, Ltd., Walsall, Eng.). Nucl. Eng., 12: 449-52(June 1967).

Fabrication procedures for Mg alloys, stainless steel, and other fuel-can materials, for Magnox, AGR, and fast reactors, are outlined. Production methods are reviewed for various designs of steam generator tubing with welded fins, integral transverse fins, internal and external longitudinal finning, and with mechanically attached fins. (UK)

28735 THE PREPARATION OF HIGH-PURITY COLUMBIUM BY THERMAL DECOMPOSITION OF COLUMBIUM PENTACHLORIDE. McCarty, Lewis V.; Bachmann, Winston T. (General Electric Co., Cleveland). Electrochem. Technol., 5: 299-301 (May-June 1967).

Distillation-purified $NbCl_5$ was decomposed at 1810 to 2000°C on 2-mil Nb wire which ultimately grew to 200 mils in dia. Analytical data for the as-grown crystal bar indicated 16 to 19 ppM of O, 1 ppM of N, 1 ppM of H, 10 ppM of Al, 60 to 160 ppM of Ta, and 10 to 190 ppM of Cl. Electron-beam melting in a vacuum furnace produced samples with low recrystallization temperature and Vickers hardness of 42 to 48, fully annealed. The residual resistivity ratio of the vacuum-melted sample drawn into wire form was $\rho 298°K/\rho 10°K = 311$. (auth)

28736 IMPROVED STABILITY OF Nb_3Sn RIBBON BY PLATING OR CLADDING WITH A HIGH-CONDUCTIVITY METAL. Schindler, H. C.; Green, R. J. (Radio Corp. of America, Harrison, N. J.). RCA Eng., 12: 24-8(Dec. 1966-Jan. 1967).

Development of superconductive materials for construction of high-field magnets is traced, with emphasis on Nb_3Sn ribbon. Development of high critical-field superconductors such as NbZr, NbTi, Nb_3Sn, and V_3Ga led to renewed efforts for evolving high-field magnets. Technics for improving the stability of vapor-deposited Nb_3Sn ribbon by utilizing different substrates, as well as Ag-plating and Cu-cladding technics are discussed, as is design of various ribbon types for superconductive magnets. The choice of materials used in the fabrication of quasi- or fully stabilized magnets depends on the specific application. Frequently, for small-bore lab magnets, the quasistable magnets are more desirable. They are wound with a 0.001-in. Ag-plated ribbon having an over-all conductor current density of 2.5×10^4 A/cm^2. For larger dia, low-field bubble-chamber magnets, completely stabilized magnets are frequently preferred. These magnets have a lower over-all conductor current density of only 9×10^3 A/cm^2. (BBB)

28737 VAPOR DEPOSITION OF NIOBIUM STANNIDE: A VERSATILE PROCESS. Nyman, F. R. (Radio Corp. of America, Harrison, N. J.). RCA Eng., 12: 11-13(Dec. 1966-Jan. 1967).

The production of Nb_3Sn, for superconductive magnets, by a vapor-phase transport technic is described. Nb_3Sn obtained by the vapor-phase H_2 reduction of the metal chlorides is a characteristically single-phase, high-purity material which has excellent properties for use in high-field superconductive magnets. A variety of ribbon substrate widths and thicknesses has been successfully coated with adherent Nb_3Sn deposits to controlled thicknesses, tailored to specific magnet applications. The vapor-deposition process was demonstrated as a practical production process, in line operations, for commercial quantities of superconductive Nb_3Sn-coated ribbon. Several stainless-steel-type materials are used to manufacture superconductive ribbon and wire for the fabrication of superconductive magnets. These high-strength alloys increase the flexibility and strength of the composite ribbon, allowing easier handling during magnet-winding and the use of considerably less magnet-support structure to contain the stresses of high fields. For example, the tensile strength of a composite ribbon composed of Nb_3Sn, 0.00025-in. thick deposited on stainless steel 0.002-in. thick is 95,000 psi at room temperature. (BBB)

28738 IMPROVEMENTS IN OR RELATING TO ZIRCONIUM ALLOYS. (to CEA). British Patent 1,061,156. Mar. 8, 1967. Priority date June 26, 1963, France.

A ternary alloy of Zr is described which has a low thermal neutron cross section, higher corrosion and creep resistance, as well as higher strength in CO_2 gas than either pure Zr or other Zr alloys at 500 to 600°C. The Zr-base alloy contains 0.5 to 3 wt % V and 0.5 to 3 wt % Cu. The Zr-base metal contains a minimum of impurities such as Al, Fe, and Si, and substantially no Hf. The alloy is stated to resist diffusion of U and can be fabricated into fuel element cans for pressurized-gas cooled nuclear reactors. (P.G.C.)

28739 IMPROVEMENTS IN THERMAL INSULATION AND INSULATING MATERIALS. Armstrong, Edward; Hawgood, John (to Darchem Engineering Ltd.). British Patent 1,061,385. Mar. 8, 1967. Filed Oct. 12, 1962.

Thermal insulation for gas or liquid cooled nuclear reactors is described which consists of internally baffled stacks of stainless steel sheets or other metallic materials. Critical spacing between adjacent sheets is effected by stainless steel wires, in mesh or zig-zag configuration, or by dimpling individual sheets. Spacing is designed to compensate for the temperature gradient between the hot and cold faces of the insulating pack and to substantially inhibit convection currents in the coolant. (P.G.C.)

28740 IMPROVEMENTS IN AND RELATING TO THERMAL INSULATION. Armstrong, Edward; Hawgood, John (to Darchem Engineering Ltd.). British Patent 1,061,630. Mar. 15, 1967. Filed June 28, 1963.

An improved method for fabrication of thermal insulating packs of stainless steel sheets for gas cooled nuclear reactor pressure vessels is reported. The construction permits relative movement of the component sheets during thermal expansion and contraction. Included in the patent is a nuclear reactor pressure vessel insulated in accordance with the described method. (P.G.C.)

28741 NUCLEAR FUEL CANS. Emley, Edward Frederick; Fisher, Philip Andrew (to Magnesium Elektron Ltd.). British Patent 1,061,398. Mar. 15, 1967. Filed Nov. 19, 1964.

Duplex cans for sheathing U fuel elements were developed in which the inner walls were Mg-base alloys containing small additions of Al, Be, Ca, Mn, Si, and/or Zn. The outer part of the cans and fins was also of the Mg base alloy but contained small additions of Be, Mn, Pb, rare earth metals, Zr, and/or Cu. The cans were shaped by extrusion, drawing, and rolling. (P.G.C.)

28742 SINTERING CERAMIC, CERMET OR POWDERED METAL SHAPES. (to U. S. Atomic Energy Commission). British Patent 1,064,012. Apr. 5, 1967. Priority date Nov. 14, 1962, United States.

Linear and cross-sectional symmetry of sintered ceramic or powdered metal rods is attained by supporting the green rods, during sintering, in V-shaped troughs. In one method inverted V-shaped troughs are used to cover the rods to compensate for shrinkage during the firing cycle, and in another method Mo rods are laid along the green shapes to supply downward compression. Also reported is a method for fabricating fuel rods of UO_2 and sintering then in V-shaped troughs of mullite sprayed with Mo. (P.G.C.)

28743 PROCESS OF PRODUCING RHENIUM FOR TUNGSTEN–RHENIUM ALLOYS BY THE IRRADIATION OF TUNGSTEN. Miller, Edward F. (to U. S. Atomic Energy Commission). U. S. Patent 3,324,005. June 6, 1967.

A process for the production of Re for W–Re alloys comprises separating ^{186}W from naturally occurring W metal, exposing the isotope to neutrons of 19 eV in a flux density of at least 10^{11} $n/cm^2/sec$, and allowing the metal to decay to yield W–Re mixtures. (AEC)

Properties Evaluations

Refer also to abstracts 28339, 28730, 28736, 28794, 28798, and 30283.

28744 (AD–641180) MAGNETIC PROPERTIES OF THIN FILMS OF NICKEL–IRON–MOLYBDENUM. Frindell, Guy H. (Naval Ordnance Lab., White Oak, Md.). May 25, 1966. 58p. (NOLTR–66–101). CFSTI $3.00 cy, $0.65 mn.

The properties of thin ferromagnetic films of Ni–Fe–Mo are studied as a function of composition and method of manufacture. Experimental data are presented and discussed on magnetostriction, anisotropy, dispersion of anisotropy, coercive force, saturation induction, magnetoresistance, and resistance. Many of these results are in general agreement with data published by other authors; the principal exception is the dependence of the coercive force on substrate temperature. (auth)

28745 (AGN–8194(Vol.2)) ALKALI METALS EVALUATION PROGRAM. THERMODYNAMIC AND TRANSPORT PROPERTIES OF POTASSIUM: PVT PROPERTIES. Achener, P. Y.; Miller, A. R.; Fisher, D. L. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). Apr. 1967. Contract AT(04-3)-368. 67p. Dep. CFSTI.

The pressure–volume–temperature properties of super-heated K vapor at 1149.8 to 1478.8°K at pressures from 2.412 to 14.14 atm were determined. The experimental method involved the use of a constant-volume capsule fitted with a null-type diaphragm for measurement of pressure. The experimental data were used to develop a virial equation of state explicit in pressure, from which the desired properties of enthalpy, entropy, specific heat, and compressibility were calculated. (auth)

28746 (EURAEC–1838) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 11, January 1–March 31, 1967. Cox, Thomas B. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Mar. 1967. Contract AT(40-1)-3208. 32p. Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Studies on the solid solubility of N in AISI Type 304 stainless steel were continued. Determination of the solid solubility limit was made at 566, 593, 954, and 981°C; thus permitting the construction of a plot of N solid solubility as a function of temperature in type 304 stainless steel. Also, the thermodynamic quantities for the solution reaction were calculated at these temperatures. Results of the heat treatment study aimed at producing a supersaturated solid solution of N in type 304 stainless steel at room temperature are included. (P.C.H.)

28747 (GAMD–5638) DETERMINATION OF DUCTILE-BRITTLE TRANSITION TEMPERATURES OF EBOR PRESSURE VESSEL SHELL, FLANGES, TOP HEAD, AND WELDS. Peinado, C. O.; Wunderlich, J. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 27, 1964. Contract AT(04-3)-187. 20p. Dep.

Nil ductility transition (NDT) values were determined for Experimental Beryllium Oxide Reactor (EBOR) pressure vessel shell, flanges, top head, and welds by Charpy V impact tests over a range of temperatures. The results of the impact tests are tabulated, along with data on mechanical properties of the materials tested. The microstructure of the materials studied was found to be fine grained. The parent metal was pearlite in a ferrite matrix. The weld metal was spheroidized carbides in ferrite. (P.C.H.)

28748 (IS–T–163) A MEASUREMENT OF THE HEAT CAPACITY OF $CaMg_2$ AND A CALCULATION OF THE COHESIVE ENERGY OF $CaMg_2$. Davison, Joseph Edward (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 48p. Dep. CFSTI.

Thesis.

The heat capacity of $CaMg_2$ was measured at 4.9 to 286.6°K with an adiabatic calorimeter. The standard entropy of $CaMg_2$ was evaluated from these data to obtain a value of 8.27 cal/g-atom/K° at 298.1°K. This value was combined with the existing entropy values of the appropriate elements to yield a value of $-.25 \pm .06$ cal/K°/gm-atom for the standard entropy of formation of $CaMg_2$ at 298.1°K. The heat content of $CaMg_2$ was measured with the aid of a Bunsen ice calorimeter at 273 to 670°K. These data were combined with the heat capacity information and existing data for

the standard enthalpy of formation of $CaMg_2$ and the heat capacities for the elements to obtain a value of −3.19 Kcal/mole for the standard enthalpy of formation at 0°K. The cohesive energies of $CaMg_2$, $SrMg_2$, and $BaMg_2$ were evaluated in the framework of the free electron theory of metals. The ground state energies of the valence electrons of the compounds were approximated as the arithmetic mean of the ground state energies of the appropriate elements. The states of higher energy were calculated in the free electron approximation. With the size ratio of the constituents fixed at the value of 1.225, a value suggested by the crystal structure of the compounds, the calculated values for the standard enthalpies of formation of $CaMg_2$, $SrMg_2$, and $BaMg_2$ are, respectively, 9.8, 7.9, and 2.8 Kcal/gm-atom. Although this model precludes an exact quantitative agreement between the calculated and experimental values, the results are in reasonable accord and the order of decreasing stability of the series $CaMg_2$, $SrMg_2$, and $BaMg_2$ is correctly reproduced. (auth)

28749 (MSAR-67-79) EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, January–March 1967. (MSA Research Corp., Evans City, Pa.). May 1967. Contract AT(11-1)-765. 44p. Dep. CFSTI.

Developments are reported for studies on: effects of high temperature Na on austenitic and ferritic steels; mechanical property testing; system operation and loop studies; sorption of C by Ni, Ni alloys, stainless steels, and steels; design of analytical magnetic traps; loop design for mechanical property testing of LMFBR structural materials; and design of high temperature-liquid metal environment extensometer. (P.C.H.)

28750 (N-67-13188) DEVELOPMENT AND EVALUATION OF MAGNETIC AND ELECTRICAL MATERIALS CAPABLE OF OPERATING IN THE 800° TO 1600°F TEMPERATURE RANGE. Quarterly Report, September 1–November 30, 1965. Kueser, P. E. (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Dec. 1965. Contract NAS3-6465. 267p. (NASA-CR-54357; QR-4). CFSTI $3.00 cy, $0.65 mn.

Screening results conducted on martensitic alloys, using additions of Ta plus W and Ta plus Si to a base composition of Fe–15% Ni–25% Co, indicate that these alloys show promise for meeting the desired creep stress (>60,000 psi at 0.4 percent creep strain), and magnetic saturation (>13 kG) at 1100°F. No problem appears to exist in meeting the goal of a coercive force of less than 25 Oe at 1200 to 1600°F in either the 27 Co–Fe-base or Co-base compositions. Comparison of electrical data on BN (boralloy), polycrystalline alumina (Lucalox), polycrystalline beryllia, and single-crystal alumina (Linde sapphire) show that pyrolytic BN has significantly lower ac losses, higher dc resistance, and exhibits less change in capacitance with temperature than any other material investigated in the temperature range from room temperature. Ceramic outgassing studies indicated that the present firing cycles applied to a ceramic using a N_2–H_2 atmosphere followed by the vacuum treatment which they undergo during brazing is sufficient for minimizing oxygen bearing outgassing products. (auth)

28751 (N-67-15683) EVALUATION OF OXIDATION-RESISTANT COATINGS FOR INERT-ATMOSPHERE APPLICATIONS. Phillips, W. M. (Jet Propulsion Lab., Pasadena, Calif.). Jan. 15, 1967. Contract NAS7-100. 24p. (NASA-CR-81191; JPL-TR-32-1014). CFSTI $3.00 cy, $0.65 mn.

A series of oxidation-resistant coatings were tested in Ar containing traces of O_2 and water vapor at 2000°F for 500 hr. Coatings tested were Sn–Al and modified silicides applied to a substrate of Nb–1 Zr and an unmodified silicide applied to a subcoating of Mo on Nb–1 Zr. Evaluation of the samples was done by metallography, microhardness testing, bend testing, and microprobe analysis. The Cr-modified silicides offered little oxidation protection under these conditions and resulted in Cr diffusion into the substrate. The Sn–Al coating produced adequate oxidation resistance despite spalling. The use of the unmodified silicide over a diffusion barrier of Mo appeared to be the most effective technique of protection. (auth)

28752 (NASA-TN-D-3941) EFFECT OF CLADDING ON EXTRUDABILITY AND PROPERTIES OF POWDER-METALLURGY TUNGSTEN. Herbell, Thomas P.; Hoffman, Charles A.; Weeton, John W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 21p. CFSTI.

Powder-metallurgy W both with and without 1/4-inch-thick Mo cladding was reduced 12:1 by extrusion at 2400 to 4000°F. With cladding, extrusion was possible with preheat temperatures as low as 2400°F. Unclad billets could not be extruded with preheat temperatures less than 2800°F. Extrusion temperature and technique (clad or unclad) affected the as-extruded hardness, grain size, and room-temperature tensile strength. Tensile strengths at 3000 and 3500°F were not influenced by extrusion temperature or technique. There was no correlation between the elevated-temperature ductility and the post-test hardness or grain size. (auth)

28753 (ORNL-TM-1771) TIME-DEPENDENT HARDNESS OF SOFT METALS. Larsen-Badse, Jorgen (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 16p. (CONF-670206-5). Dep. CFSTI.

From 96th Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Los Angeles, Calif.

Room-temperature Vickers hardness tests were carried out on In, Sn, and Pb for times of loading between 1 and 60,000 sec and with applied loads in the range 500 to 1600 g. The applied load was found to have no influence on the time-hardness relation within a wide time range. The hardness decreased with increased time of loading according to $t \propto H_v^{-y}$. For long times of loading the hardness deviated from this relation towards lower values. The results are explained on the basis of previous experiments on creep under flat punches for the same materials. It is shown that $y = 2n + 1$, where n is the exponent of the uniaxial creep relation $\dot{\epsilon} \propto \sigma^n$. (auth)

28754 (ORNL-TM-1807) EFFECT OF TITANIUM ADDITIONS ON THE STRESS-RUPTURE PROPERTIES OF TYPE 304 STAINLESS STEEL. Bloom, E. E. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 24p. Dep. CFSTI.

The effects of small additions of Ti on the stress-rupture properties of types 304 and 304L stainless steel were determined. Stress-rupture tests were performed on rod specimens at 704 and 815°C. For tests in the solution-treated condition, Ti increased the rupture life and decreased the minimum creep rate by approximately an order of magnitude. This increase in strength was attributed to the locking of dislocations during creep and was demonstrated by the appearance of small precipitates on dislocations. When C was removed from solution by prior precipitation, dislocation locking did not occur and the minimum creep rate was increased. The Ti-bearing steels failed by a mixture of transgranular and intergranular fracture whereas type 304 stainless steel fractured intergranularly. (auth)

28755 (ORNL-TM-1883) ELECTROCHEMICAL MEASUREMENTS ON NIOBIUM AT ELEVATED TEMPERATURES. Gadiyar, H. S.; Bacarella, A. L.; Sutton, A. L. (Oak Ridge National Lab., Tenn.). June 2, 1967. Contract W-7405-eng-26. 16p. Dep. CFSTI.

Preliminary studies on the electrochemistry of film formation on chemically polished Nb at 200°C are reported. During film formation in 0.05 M K_2SO_4 at 200°C, the rate steadily decreased first up to about 100 min and then became somewhat steady, changing from 1.0×10^{-6} to 5.5×10^{-7} amp/cm² from 110 to 5,600 min. It was found that film growth does not follow logarithmic, cubic, or hyperbolic sine function relations. The results indicated the formation of a porous film or film dissolution. Corrosion rates (at anodic potential + 0.1 V) in 0.05 M H_2SO_4 decreased to about 3.2×10^{-6} amp/cm² after about 60 to 70 min exposure at 200°C, remained steady in the region for sometime up to around 300 min, and then again increased to values of 1×10^{-5} amp/cm² at 900 to 1000 min exposure. (P.C.H.)

28756 (SC-RR-67-368) DYNAMIC BEHAVIOR OF BERYLLIUM. Munson, D. E. (Sandia Corp., Albuquerque, N. Mex.). June 1967. 10p. Dep. CFSTI.

The dynamic behavior of QMV Be sheet was determined from plate impact experiments. It has a pronounced elastic-plastic, rate sensitive stress-strain behavior. Suitable analysis to obtain bulk propagation velocities indicates two important functions with a phase change at approximately 93 kbar. (auth)

28757 (SWRI-1228P1-37) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. (1) CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. (2) FAST FRACTURE TESTS OF ONE-HALF SCALE PRESSURE VESSELS. (3) EFFECT OF WELD DEFECTS ON THE FATIGUE STRENGTH OF A302B STEEL. Progress Report No. 21, October 1, 1966–January 1, 1967. Pickett, A. G.; Grigory, S. C. (Southwest Research Inst., San Antonio, Tex.). Feb. 24, 1967. Contract AT(11-1)-1228. 21p. (SWRI-1228P5-35; SWRI-1228P2-35). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are presented of destructive tests on steel pressure vessels. Cyclic pressure tests were made on large size pressure vessels, 36 in. ID of 2 in. wall thickness, and fast fracture tests on one-half scale vessels. Tests were also made to determine the effects of weld defects on the fatigue strength of A302B steel. (P.G.C.)

28758 (TID-23826) THE EMBRITTLEMENT CHARACTERISTICS OF A LOW-SILICON MODIFIED COBALT-BASE ALLOY (L-605) AT 1200 AND 1600°F. [Period Covered]: July 1, 1965–June 30, 1966. Nejedlik, J. F. (TRW Equipment Labs., Cleveland, Ohio). Contract AT(11-1)-Gen-8. 77p. (ER-6870). Dep. CFSTI.

For Atomics International, Canoga Park, Calif.

An investigation was made on the effects of low-Si content in L-605 (Haynes 25 alloy) on mechanical properties before and after aging at 1200 and 1600°F for times up to 2500 and 1000 hours, respectively. The effects of low-Si content upon the thermal coefficient of expansion and dimensional stability were also investigated. It was found that the aging phenomenon is related to variations in exposure temperature, exposure time, prior thermal and mechanical history, and composition. The low-Si heats were definitely less prone to embrittlement than high-Si heats for short aging times. Long aging times (over 7000 hours) yielded identical degrees of embrittlement regardless of Si content; the aging reaction was only delayed. Carbide precipitation by low-temperature (2050 to 2150°F) annealing following cold work was beneficial in reducing subsequent embrittlement. High temperature (2250°F) annealing was detrimental. The aging response was not diffusion rate controlled; aging behavior could not be extrapolated safely from one temperature to another. The Fe content and grain size were not significant factors in embrittlement. The C content of the alloy was a factor only for the low-Si (<0.48% Si) heats; for these heats, the ductility was improved with an increase in C content. Cold work accelerated the embrittlement reaction at 1200°F but was beneficial at 1600°F. The coefficient of thermal expansion was not affected by Si content; neither was the stress-rupture strength nor were other mechanical properties. Aging at 1200°F for 2500 hours produced a dimensional contraction of 60 μin./in., and aging at 1600°F for 1000 hours produced a dimensional contraction of 240 μin./in. Conditioning (preaging following cold work and then low-temperature annealing) was markedly beneficial at the 1600°F aging temperature and slightly beneficial at the 1200°F aging temperature. (auth)

28759 (UCRL-17334) ELECTRON MICROSCOPIC STUDY OF MARAGING STEEL. Cheng, I-Lin (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1967. Contract W-7405-eng-48. 44p. Dep. CFSTI.

Thesis.

A careful examination of one system of maraging steels based on Ni–Co–Ti–Fe has been done primarily using electron microscopy, in an attempt to delineate the hardening mechanism in terms of the substructural changes. The results indicated that precipitation hardening is the main strengthening mechanism. Upon plastic deformation, the specimens exhibited a brittle failure under typical maraging treatments which gave microstructures having grain and/or martensite sub-boundary precipitation. Identification of precipitates by electron diffraction and electron beam microprobe indicated that they were a (Ni–Ti) intermetallic compound, probably, Ni_3Ti. The orientation relationship of them with the matrix is $(001)_\eta||(110)_\alpha$, $[2\bar{1}\bar{1}0]_\eta||[1\bar{1}1]_\alpha$. An analysis was made using both the Orowan and Ansell models to account for the initial yield stress of this alloy. It was concluded that the Ansell model is the controlling one. (auth)

28760 (UCRL-17454) THERMAL PULSING OF METALS UNDER HIGH PRESSURE. Stark, Walter Alfred Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1967. Contract W-7405-eng-48. 95p. Dep. CFSTI.

Thesis.

The theory and instrumentation of a method for measuring the heat capacities of metals and semiconductors as functions of temperature and pressure in the Bridgman opposed-anvil apparatus are described. The technique involves measurement of the rate of temperature increase in the sample as electrical energy is added at a known rate for a short period of time. The method was used to follow the heat capacity anomaly near the Curie temperature T_c for Gd at pressures up to 20 kb; dT_c/dP was found to be −1.3°K/kb. The heat capacity of Fe was measured at 150 to 300°K for pressures between 20 and 100 kb; within the experimental uncertainty of 5 to 6% no variation of the heat capacity with pressure was observed in this interval. Some limitations of the present setup are discussed. A variation of the above technique using larger current pulses to thermally shock a metal under pressure was applied to the high pressure transformations of Bi, Sn, and Fe. This method appears to yield thermodynamic values of transition pressures and the following fixed points were obtained: Bi, 81 ± 4 kb; Sn, 99 ± 4 kb; and Fe, 118 ± 6 kb. The dependence of the electrical resistance of Fe on the three-halves power of the absolute temperature at pressures greater than 20 kb was noted. (auth)

28761 (WAPD-TM-591) DEFORMATION AND COLLAPSE OF FUEL ROD CLADDING DUE TO EXTERNAL PRESSURE. Griffin, D. S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 46p. Dep. CFSTI.

Approximate methods are given for analyzing the effects of external pressure on Zircaloy fuel rod cladding. The structural behavior of the clad is idealized to be independent of the behavior of the fuel. Phenomena considered include inelastic and creep collapse, inelastic deformation (ovality), diametral shrinkage, dimpling, and axial wrinkling. Comparisons with experimental results are given where available. (auth)

28762 (WAPD-TM-651) FRACTURE OF CYLINDRICAL FUEL ROD CLADDING DUE TO PLASTIC INSTABILITY. O'Donnell, W. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1967. Contract AT(11-1)-Gen-14. 14p. Dep. CFSTI.

A failure mechanism is described for the cladding of cylindrical fuel rods whereby fracture occurs as a consequence of plastic instability induced by fuel swelling. The loss of work hardening capacity from irradiation damage reduces the nominal failure strain by an order of magnitude, resulting in fracture at nominal strains of about 2% with Zircaloy cladding. When recently reported in-pile fuel rod failure experiments were compared with theoretical predictions, good agreement resulted. The results provide a basis for setting allowable clad strain design limits. It was carried out in support of the LWB–LSBR fuel element development effort. (auth)

28763 INTERNAL FRICTION OF COLD-WORKED NIOBIUM AND TANTALUM CONTAINING BOTH OXYGEN AND NITROGEN. van Ooijen, D. J. (Mullard Research Labs., Redhill, Eng.); van der Goot, A. S. Philips Res. Rep., 22: 150-60(Apr. 1967).

The internal friction of annealed and cold-worked Nb wires and Ta wires containing both O_2 and N_2 was measured up to a temperature of 700°C in vacuum. After cold-working, in both metals cold-work peaks due to O_2 and due to N_2 were found in addition to the Snoek peaks. The peak temperatures are about 420°C and 500°C, respectively, for O and N in Nb and 470 and 540°C for O and N in Ta. From the changes of the heights of the Snoek peaks and the cold-work peaks of O and N after cold-working and after subsequent heat treatment it was found that at low temperatures the O atoms segregate at the dislocations. They are replaced irreversibly by the N atoms after heating above 440°C. In both metals the Snoek peak due to N is increased upon deformation. It decreases again upon heating around 440°C. (auth)

28764 LATTICE SPECIFIC HEATS OF THALLIUM AND YTTRIUM. Gupta, R. P. (Banaras Hindu Univ., India). Phys. Status Solidi, 20: 291-4(Mar. 1, 1967).

The lattice specific heats of Tl and Y are calculated using the electron gas model of Gupta and Dayal for hexagonal metals. The interactions are restricted to fourth neighbors. The force constants are determined from experimental values of the elastic constants. The $\theta-T$ curves calculated from the computed specific heats show a fairly satisfactory agreement with the experimental values, i.e., the difference is not greater than 3% for Tl and 6% for Y. (auth)

28765 LIQUID SODIUM. Addison, C. C. (Univ. of Nottingham, Eng.). Endeavour, 26: 91-5(May 1967).

The properties of liquid Na and some evidence for the existence of order in the liquid phase are discussed. The electric properties of liquid Na are described. Solubilities of Li, Mg, K, Ga, Rb, Pb, Ag, Cd, In, Sn, Sb, Cs, Ba, Au, Hg, Tl, and Bi in liquid Na are given. Solutions of nonmetals and reactions between nonmetals and metals in liquid Na are considered. (M.C.G.)

28766 SUCCESSIVE STRESS RELAXATION OBSERVED ON MOLYBDENUM POLYCRYSTALS IN PRE-YIELD REGION. Matsumoto, Keishi (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo). J. Phys. Soc. Jap., 22: 803-9(Mar. 1967).

In order to study the plastic deformation behavior of bcc metals in the region near the yield point, the successive stress relaxation method was developed. Results obtained with Mo polycrystals having two different yield strengths were analyzed to show that the true plastic strain rate can be expressed in terms of the product of two functions, one being dependent solely on the plastic strain while the other on the applied stress only, i.e., $\dot{\epsilon} \propto f(\epsilon)g(\sigma)$. It turned out that those functions are in the form of $f(\epsilon) \propto \epsilon$ and $g(\sigma) \propto \sigma^m$ or $\exp(-D/\sigma)$, respectively. This appears to support the Johnston–Gilman concept for the region concerned, on which the contribution of mobile dislocations to yielding behavior was examined separately in terms of the mobility and the density. Various parameters characterizing dislocations were compared between the two kinds of samples. (auth)

28767 EFFECT OF ORIGINAL CRYSTALLOGRAPHIC ORIENTATION ON THE RECRYSTALLIZATION TEMPERATURE OF

WIRE OBTAINED FROM MOLYBDENUM SINGLE CRYSTALS. Savitskii, E. M.; Burkhanov, G. S.; Bokareva, N. N.; Grokhochinskii, A. S.; Ottenberg, E. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 172: 87-9(Jan. 1, 1967). (In Russian).

Pure Mo single crystals were grown along three different axes and wires were drawn from these crystals and annealed at various temperatures to determine the temperature of recrystallization. Wires obtained from single crystals with an original orientation of 24° from [100] had the lowest temperature of recrystallization (650°C) and wires obtained from crystals with an orientation of [110] had the highest temperature of recrystallization (950°C). Microalloying with Zr and Ti significantly increases the temperature of the beginning of recrystallization. Wires obtained from microalloyed Mo single crystals with an orientation of [110] had the highest temperature of recrystallization (1700°C) and those obtained from crystals with an orientation of 24° from [100] had the lowest (1300°C). Thus, by growing single crystals of Mo microalloyed with Zr and Ti, along the [110] and [100] orientations, the recrystallization temperatures of wires obtained from the crystals can be increased to 1600 to 1700°C. (ATD)

28768 RECOVERY OF DEFORMED NIOBIUM AND TANTALUM DEGASSED IN ULTRAHIGH VACUUM. Koethe, A.; Schlaet, F. (Institut fuer Metallphysik und Reinstmetalle, Dresden). Phys. Status Solidi, 21: K73-6(May 1, 1967).

An internal friction measurement of an annealed pure Nb sample is discussed together with its interpretation. Isochronal recovery curves of rolled pure Nb with 20 to 75% reduction show a continuous decrease of residual resistivity up to 300°C without any distinct recovery stage; above 300°C, the resistivity begins to rise, probably due to O_2 pickup. A summary graph of resistivity increase due to deformation and recovery is presented for both pure and O_2-doped Nb. An isochronal recovery curve for 50%-rolled Ta indicates behavior similar to that of Nb. The observed recovery behavior is ascribed to rearrangements of dislocations. (D.L.C.)

28769 INVESTIGATION OF THE QUASI-LOCAL LEVEL IN THE VIBRATIONAL SPECTRUM OF THE Ti LATTICE WITH HEAVY IMPURITY ATOMS. Chernoplekov, N. A.; Panova, G. Kh.; Zemlyanov, M. G.; Samoilov, B. N.; Kutaitsev, V. I. (Inst. of Atomic Energy, Moscow). Phys. Status Solidi, 20: 767-70(Apr. 1, 1967).

A quasi-local level appears in the vibrational spectrum of Ti lattices containing 5 at. % U. This is investigated by neutron inelastic scattering techniques and by measuring the low-temperature heat capacity. The results obtained are found to be in satisfactory agreement with theoretical calculation. (auth)

28770 THERMAL EXPANSION OF SOME CUBIC REFRACTORY COMPOUNDS OF THORIUM. Aronson, S.; Cisney, E.; Gingerich, K. A. (Brookhaven National Lab., Upton, N. Y. Battelle Memorial Inst., Columbus, Ohio). J. Amer. Ceram. Soc., 50: 248-52(May 21, 1967). (BNL-10580).

The thermal expansion of a number of cubic refractory compounds of Th was measured by high-temperature x-ray diffraction. The coefficients of thermal expansion range from 7.5 to 8.2 × 10^{-6}/°C for ThN, $ThC_{0.84}$, $ThP_{0.71}$, $ThP_{0.91}$, and Th_3P_4 between 900 and 1300, 1450, 1750, 1750, and 1150°C, respectively; the coefficients for ThS, ThB_6, and ThO_2 are in the range of 11.2 to 12.0 × 10^{-6}/°C between 900 and 1400, 1700, and 2100°C, respectively. Results are discussed in relation to other properties of these compounds. (auth)

28771 TURBULENT HEAT TRANSFER OF LIQUID CURRENTS OF HIGH HEAT CONDUCTIVITY. Borishanskii, V. M.; Zablotskaya, T. V. At. Energ. (USSR), 22: 135-7(Feb. 1967). (In Russian).

The coefficients of turbulent heat transfer (a_T) were calculated on the basis of measurements of the temperature field in currents of light and heavy fused metals. The results are graphed. (J.S.R.)

28772 THERMODYNAMICS OF FORMATION OF BINARY RARE EARTH-MAGNESIUM PHASES WITH CsCl-TYPE STRUCTURES. Ogren, J. R.; Magnani, N. J.; Smith, J. F. (Ames Lab., Iowa). Contract W-7405-eng-82. Trans. Met. Soc. AIME, 239: 766-71(June 1967). (IS-1472).

The vapor pressures of Mg over binary alloys of Mg with twelve of the rare earth elements were measured by the Knudsen effusion method at 675 to 910°K. These vapor-pressure measurements were combined with data concerning terminal Mg solubility and the vapor pressure of pure Mg to evaluate the standard free energies of phase formation. These free-energy values indicate that the CsCl structures of the heavy rare earths tend to be somewhat less stable than those of the light rare earths. This behavior correlates with differences observed in other alloy systems wherein a phase appears, disappears, or changes crystal structure as the atomic number of the rare earth component is changed. This behavior also appears to correlate with the structural variations within the rare earth elements themselves, and it is speculated that variations in the spatial extent of the 4f orbitals are responsible. (auth)

28773 HYDROGEN EMBRITTLEMENT OF NIOBIUM-OXYGEN AND NIOBIUM-NITROGEN SOLID SOLUTIONS AT ROOM TEMPERATURE. Kieger, R.; Clauss, A.; Forestier, H. Mem. Sci. Rev. Met., 64: 195-201(Feb. 1967). (In French).

After a preliminary study of conditions for the preparation of solid solutions of Nb-O_2 and of the evidence of dissolved O_2, the mechanical properties of samples in air and H_2 were compared. A study of the embrittlement of Nb-O_2 solid solutions by H_2 led to a consideration of the possible effects of other elements dissolved in Nb, particularly N_2. Results of preliminary tests of the Nb-N_2 solid solutions showed that testing them is more difficult than Nb-O_2 solid solutions because of preparation complexities. The effect of grain size on the embrittlement in the Nb-N_2 solution was studied. A mechanism is suggested for embrittlement of Nb by H_2. (J.S.R.)

28774 EFFECTS OF DEFORMATION ON THE ELECTRICAL RESISTIVITY OF MOLYBDENUM SINGLE CRYSTALS. Whitmire, L. D.; Brotzen, F. R. (Rice Univ., Houston, Tex.). Trans. Met. Soc. AIME, 239: 824-7(June 1967).

Single crystals of high-purity Mo were deformed at 195 to 473°K, and the effect of deformation on the electrical resistivity was determined. To separate the resistivity components of point and line defects some crystals were annealed at 473°K. The rate of resistivity increase with strain was nearly linear and was strongly dependent on the deformation temperature. Point defects were annealed out without any effect on the flow stress. At low temperatures the flow stress was a linear function of the square root of the resistivity increase attributable to dislocations. (auth)

28775 ISSLEDOVANIYA PRI VYSOKIKH TEMPERATURAKH. (High-Temperature Research). Novikov, I. I.; Strelkov, P. G. (eds.). Novosibirsk, USSR, Izdatel'stvo Nauka Sibirskoe Otdelenie, 1966. 124p. (In Russian).

Separate abstracts were prepared for 2 of the 6 papers on high-temperature research. (M.C.G.)

For abstracts of individual papers see: 28776 and 28777.

28776 HEAT CAPACITY AT HIGH TEMPERATURES AND FORMATION OF VACANCIES IN REFRACTORY METALS. Kraftmakher, Ya. A. pp 5-54 of Issledovaniya pri Vysokikh Temperaturakh. Novikov, I. I.; Strelkov, P. G. (eds.). Novosibirsk, USSR, Izdatel'stvo Nauka Sibirskoe Otdelenie, 1966. (In Russian).

A modulation method for measurement of the heat capacity of metals on samples in a wide temperature interval was developed. With the method it is possible to obtain a high sensitivity even with small amplitudes of temperature modulation of the sample. The heat capacity at high temperatures was measured for a series of refractory metals: W(1,500 to 3,600°K), Ta(1,200 to 2,900°K), Mo(1,300 to 2,500°K), Nb(1,300 to 2,700°K), and Pt(1,000 to 2,000°K). From data obtained the energies for the formation of vacancies and their concentration were determined for the metals studied. (tr-auth)

28777 THERMAL CONDUCTIVITY AND HEAT TRANSFER OF METALS AT HIGH TEMPERATURE. Kraev, O. A.; Stel'makh, A. A. pp 55-74 of Issledovaniya pri Vysokikh Temperaturakh. Novikov, I. I.; Strelkov, P. G. (eds.). Novosibirsk, USSR, Izdatel'stvo Nauka Sibirskoe Otdelenie, 1966. (In Russian).

A method for determination of the thermal conductivity of metals at high temperature was developed. The method was based on the emission of the temperature field in flat samples. The characteristics of the method are summarized as follows: small-dimension samples were used; annealing and creation of temperature oscillation was carried out by electron bombardment; the temperature was measured at one point of the samples by photoelements; by means of this method the thermal conductivity was measured and the heat transfer was calculated for W(1,600 to 3,000°C), Ta(1,600 to 2,880°C), Mo(1,600 to 2,250°C), and Nb(1,500 to 2,300°C). (tr-auth)

Structure and Phase Studies

Refer also to abstracts 28730, 28760, 28772, 28776, 28794, 28856, 29168, and 29360.

28778 (UCRL-14669) QUANTITATIVE DETERMINATION AND ANALYSIS OF TEXTURE. Kahn, J. S. (California Univ., Livermore. Lawrence Radiation Lab.); Bragg, R. H. (Lockheed Aircraft Corp., Sunnyvale, Calif.). Apr. 24, 1967. Contract W-7405-eng-48. 41p. (CONF-660619-8). Dep. CFSTI.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif.

X-ray methods are presented for accurately determining quantitatively the crystallographic orientation distribution of crystallites in a polycrystalline material. The relation between observed and corrected x-ray diffraction intensities is treated, including differences caused by absorption and defocusing. The absorption factors are derived from measurements of the scattered (Compton) background radiation and recourse to tables is eliminated. The defocusing is derived from geometrical considerations. It is shown that the specimen serves as its own random sample; the intensity data I (α,β) for the coordinates (α,β) of the usual polar net are normalized to random units by using the factor $2\pi/\iint I(\alpha,\beta) \sin \alpha d\alpha d\beta$. The observed orientation distributions generated from x-ray analysis can be represented by superpositions of Gaussian distributions with maxima at appropriate peak positions (α_1,β_1). Criteria for goodness of fit and the identification of the appropriate form of the distribution are derived. The test of a hypothesis of random orientation against an alternative of preferred orientation is discussed for non-x-ray techniques. The statistic employed is shown to have a normal of Gaussian distribution. This distribution establishes the criterion for accepting or rejecting the hypothesis of randomness. The procedure is invariant for the two-dimensional case, and may be extended to three dimensions where it is not invariant. (auth)

28779 (UCRL-17462) VACANCY MODELS FOR CONCENTRATED BINARY ALLOYS. Cheng, Ching-yao (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1967. Contract W-7405-eng-48. 84p. Dep. CFSTI.

Thesis.

Four models (Smeared-Displacement, Simple-Displacement, Modified Vacancy-Energy, and Vacancy-Energy Models) for estimating the effect of short-range ordering (or clustering) on the equilibrium concentration of vacancies in binary alloys are developed in terms of statistical thermodynamics. The Smeared-Displacement, Simple-Displacement, and Modified Vacancy-Energy Models assume that the energy to produce a vacancy can be estimated from the change in bond energy when an atom is displaced from the bulk of the crystal to the surface. Each model differs, however, relative to the details of the environment about vacancies that are taken into consideration. All such models suggest that the vacancy concentration decreases as a result of ordering. The Vacancy-Energy Model is physically more realistic and more detailed but somewhat less tractable than the other models. It assumes that the free energy to produce a vacancy depends primarily on the immediate environment of the vacancy. The same four models were also used for estimating the effects of long-range ordering on the equilibrium concentration of vacancies in binary alloys with $L2_0$ (bcc) or $L1_2$ (fcc) lattice. (P.C.H.)

28780 (MLM-141(tr)) THE STRUCTURE OF THE ζ-PHASE IN THE Be–B SYSTEM. Kondrashev, Yu. D.; Markevich, G. S.; Markovskii, L. Ya. Translated by Claude R. Hudgens (Mound Lab., Miamisburg, Ohio), from Zh. Neorg. Khim., 11: 1461-2 (1966). 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Powder diffraction studies were made on the B–Be system. Visual inspection of the powder diagram of the ζ phase showed a similarity to the powder diagrams of $B_{13}C_2$ and especially $B_{13}O_2$. Indexing of the powder diagram on a hexagonal cell, by assuming the ζ phase isostructural with these compounds, led to good agreement between experimental and calculated interplanar spacings. Comparative data for $B_{13}O_2$ are given. Hexagonal cell constants for the ζ phase are a = 5.461 ± 0.005, c = 12.42 ± 0.01 Å (for $B_{13}O_2$, a = 5.37, c = 12.31 Å). (P.C.H.)

28781 THE STRUCTURE OF β–$TaCo_3$ AND THE EFFECT ON THE SUBSTITUTION OF Ta AND Co BY RELATED ELEMENTS. Ponsioen, J. C. M. A.; van Vucht, J. H. N. Philips Res. Rep., 22: 161-9(Apr. 1967).

The structure of the stable phase β–$TaCo_3$ is shown to be of the rhombohedral $BaPb_3$ type with a = 6.969 Å, α = 43°42′ (hexagonal description: a = 5.186 Å, c = 18.87 Å, c/a = 3.64), space group No. 166, D^5_{3d}, R3m. Its composition is about $TaCo_{3.0}$. In the pseudobinary systems VCo_3–$MoCo_3$ and VCo_3–WCo_3 structures of the same type were found to be single-phase at the composition $(V_{0.75}, Mo_{0.25})Co_3$ and $(V_{0.75}, W_{0.25})Co_3$, respectively, being in equilibrium with the related structures of the VCo_3 type at the one side and of the Ni_3Sn type at the other. In the V–Nb–Co system another $BaPb_3$-type phase was found at the composition $(V_{0.5}, Nb_{0.5})Co_4$. In the $TaCo_3$–$TaNi_3$ system specimens with the composition $TaCoNi_2$ were found single-phase with the Ni_3Sn-type structure. This phase is at 1000°C in equilibrium with the $BaPb_3$-type structure at the one side and the orthorhombic Cu_3Ti-type structure of $TaNi_3$ at the other one. (auth)

28782 PHASE DIAGRAM OF THE MOLYBDENUM–TITANIUM–ZIRCONIUM SYSTEM. Prokoshkin, D. A.; Zakharova, M. I. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 172: 1382-4(1967). (In Russian).

120 Mo–Ti–Zr alloys with fixed Ti content of 10 to 90 at. % were levitation or arc melted, investigated by various methods of physiocochemcial analysis and, on the basis of obtained results, eleven sections of the ternary phase diagram of the Mo–Ti–Zr system were plotted. The phase boundary line was determined with homogenized alloys quenched from 600 to 1200°C, annealed at 1400°C, and furnace cooled. In all the isothermic sections, β_1 and β_2 solid solutions were found on the Mo and Zr bases, respectively. The critical temperature of saturated solid solution (27.5 at. % Ti and 37.5 at. % Zr) was 1620 ± 25°C. With temperature decreased to 1575 ± 10°C, a peritectic-type compound and δ-phase formed on the base $ZrMo_2$ lattice. At 600°C, the homogeneous area of β^5 solid solution passed from the Mo corner to the Zr corner, and separate α^5–β^5 phases, adjacent to the Ti corner, passed from the Mo–Zr side. The same area of α^5 phase in Ti and Zr corners propagated in the range 0.2 to 0.3 at. % Mo. The δ^5-phase was observed in alloy with 13 at. % Ti and 33.3 at. % Zr. The solubility of Ti and Zr in Mo significantly changed with changing temperature. (ATD)

28783 THE CRYSTAL STRUCTURES OF THE COMPOUNDS $LaAl_4$, $CeAl_4$, $PrAl_4$, AND $NdAl_4$. Zaluts'kii, I. I.; Krip'yakevich, P. I. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 4, 362-6(Apr. 1967). (In Ukrainian).

The crystal structure of the compound $LaAl_4$ has been determined by single crystal and powder x-ray diffraction analyses. This compound possesses the orthorhombic structure of a new type [space group Imm2, $2La^1$ in 2(a) 00z, z = 0; $4La^2$ in 4(d) 0yz, y = 0.187, z = 0.477; $2Al^1$ in 2(a) z = 0.4165; $2Al^2$ in 2(a) z = 0.6715; $2Al^3$ in 2(b) 0(1/2)z z = 0.302; $2Al^4$ in 2(b) z = 0.786; $4Al^5$ in 4(d) y = 0.138, z = 0.235; $4Al^6$ in 4(d) y = 0.309, z = 0.360; $4Al^7$ in 4(d) y = 0.362, z = 0.605; $4Al^8$ in 4(d) y = 0.191, z = 0.7295]; a = 4.434 Å, b = 13.148 Å, c = 10.125 Å. The compounds $CeAl_4$ (a = 4.389 Å, b = 13.011 Å, c = 10.072 Å). $PrAl_4$ (a = 4.376 Å, b = 12.966 Å, c = 10.039 Å), and $NdAl_4$ (a = 4.368 Å, b = 12.947 Å, c = 10.008 Å) also belong to the $LaAl_4$ type. (auth)

28784 TUNGSTEN RECRYSTALLIZATION IN THE ALLOYS TUNGSTEN–NICKEL–IRON. (COMMUNICATION 1). Frantsevich, I. N.; Teodorovich, O. K.; Bazhenova, L. G. Porosh. Met., Akad. Nauk Ubr. SSR, No. 5, 68-74(May 1967). (In Russian).

Recrystallization processes of the W phase in the 90W–7Ni–3Fe alloy were investigated in relation to the degree of strain and temperature of annealing. The recrystallization diagram of the W phase is plotted. It was determined that W recrystallization in strained alloys occurs at 900°C. (auth)

28785 DIAGRAM OF TUNGSTEN–BORON SYSTEM STATE. Portnoi, K. I.; Romashov, V. M.; Levinskii, Yu. V.; Romanovich, I. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 75-80(May 1967). (In Russian).

The state diagram of W–B systems was investigated over a range of concentrations by thermal, metallographic, x-ray and local X-spectral analyses and by measuring the microhardness. The lines of liquid and solid states were determined; the domains of existence of the separate phases were established. The diagram of state of W–B system is suggested. (auth)

28786 THE TERNARY SYSTEMS Ti–Zr–C AND Ti–Hf–C. Voroshilov, Yu. V.; Gorshkova, L. V.; Popova, N. M.; Fedorov, T. F. Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 81-4 (May 1967). (In Russian).

The systems Ti–Zr–C and Ti–Hf–C were investigated by means of x-ray and microstructure analyses. The phase equilibria of these systems were established at 600 and 800°C. The break of the solid solution ZrC–TiC was found, and existence of the solid solution HfC–TiC was confirmed. (auth)

28787 THE SYSTEM W–V–Si. Gladyshevskii, E. I.; Fedorov, T. F.; Skolozdra, R. V.; Gorshkova, L. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 85-8(May 1967). (In Russian).

The system W–V–Si was investigated by means of x-ray and microstructure analyses. The phase equilibria were established at 1000°C. The existence of the uninterrupted solid solutions between compounds W_5Si_3 and V_5Si_3 was established. The uninterrupted solid solutions between compounds W and V at 1000°C breaks in two solid solutions: W in V (30 at. % W) and V in W (55 at. % V). (auth)

28788 YTTERBIUM–LEAD SYSTEM. McMasters, O. D.; Gschneidner, K. A. Jr. (Ames Lab., Iowa). Contract W-7405-eng-82. Trans. Met. Soc. AIME, 239: 781-5(June 1967). (IS-1461).

Differential thermal, metallographic, and x-ray parametric methods were used to establish the Yb–Pb phase diagram. The terminal solid solubilities in the system are less than 0.2 at. %. Lead additions lower the 792°C transformation temperature of pure Yb at 787°C by means of an inverted peritectic reaction. Yb additions raise the 327°C melting point of Pb to 329°C by means of

a peritectic reaction. Three intermetallic compounds Yb_2Pb, YbPb, and $YbPb_3$ melt congruently at 1246, 1116, and 740°C, respectively. Yb_5Pb_3 forms by a peritectic reaction at 1150°C. Yb_2Pb crystallizes in the $PbCl_2$ (C23) type structure and the orthorhombic lattice constants are $a_0 = 7.478$, $b_0 = 5.225$, and $c_0 = 9.549$ Å. Yb_5Pb_3 crystallizes in the Mn_5Si_3 ($D8_8$) type structure. The hexagonal lattice constants for this phase area $a_0 = 9.325$ and $c_0 = 6.929$ Å. $YbPb_3$ crystallizes in the cubic $AuCu_3$ ($L1_2$) type structure with $a_0 = 4.8628 \pm 0.0008$ Å. YbPb is dimorphic with the structure change occurring at 507°C on heating. The crystal structures of the two forms were not determined. Eutectic reactions occur at 5.1 at. % Pb and 769°C, 44.5 at. % Pb and 1086°C, and 68.0 at. % Pb and 717°C. (auth)

28789 TWINNING IN BERYLLIUM BINARY ALLOYS DURING PRESSURIZATION IN A SOLID MEDIUM. Kossowsky, R. (Curtiss-Wright Corp., Wood-Ridge, N. J.). Trans. Met. Soc. AIME, 239: 828-36(June 1967).

Structural changes in Be–Cu, Be–Ni, Be–Ag, and Be–Fe alloys pressurized in a solid medium were investigated by resistivity measurements, x-ray diffraction in situ, and metallographic examination. Limited tests in liquid medium were also conducted. Good correlation was obtained between changes of slope of relative resistance vs pressure and changes in diffraction pattern. Metallographic examination revealed that the Cu, Ag, and Ni alloys twin heavily due to the application of pressure at room temperature. Using polarized light technique $\{\bar{1}012\}$, $\{\bar{1}011\}$, and possible $\{\bar{1}010\}$ twinning planes were identified. At elevated temperature twinning was mostly confined to the $\{\bar{1}012\}$ planes. Although twinning could be promoted by application of hydrostatic pressure (liquid medium), it was strongly enhanced by the presence of a nonhydrostatic shear component due to pressurization in a solid medium. It was further observed that a decrease in grain size inhibited twinning activity. (auth)

28790 PLUTONIUM–LANTHANUM SYSTEM. Ellinger, F. H.; Land, C. C.; Johnson, K. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 239: 895-8(June 1967). (LA-DC–8268).

The Pu–La alloy system was studied by thermal, micrographic, and x-ray diffraction methods. It is characterized by a liquid miscibility gap, a maximum solubility of about 20 at. % Pu in γ-La and 19 at. % Pu in β-La, very little solubility of La in the Pu allotropes, and the absence of intermediate phases. (auth)

28791 CRYSTALLOGRAPHIC INTERPRETATION OF THE PREFERRED ORIENTATION OF LARGE GRAINS IN DOPED TUNGSTEN WIRE. Opinsky, A. J. (General Electric Co., Cleveland). Trans. Met. Soc. AIME, 239: 919-20(June 1967).

The crystallographic link between the ⟨110⟩ (cold-worked) fiber texture and the preferred orientation of the large grains in doped W wire was investigated. This link can be provided through the concept of coincidence-type boundaries. It is shown to be possible that the grain growth process may begin by the passage of a coincidence boundary into a ⟨110⟩ fiber. The preferred orientation of the large grains was correlated with the presence of off-oriented grains. (M.C.G.)

Radiation Effects

Refer also to abstracts 28730, 28867, and 30258.

28792 (ANL–7266) HYDROGEN EMBRITTLEMENT IN IRRADIATED STEELS. Rossin, A. D. (Argonne National Lab., Ill.). Feb. 1967. Contract W-31-109-eng-38. 73p. Dep. CFSTI.

H_2-charging conditions that completely embrittle type 4340 high-strength steel have a negligible effect on 212-B pressure-vessel steel in tensile and delayed-failure tests. Much higher H_2 charges reduce the notch-tensile strength slightly. Delayed failure is observed only at stresses above 90% of the notch-tensile strength of the hydrogenated 212-B. Tests on 212-B that had been irradiated to give a 35% increase in strength and an NDT temperature shift of 94°C showed the same relationship between delayed-failure limits and notch-tensile strength. Catastrophic embrittlement due to H_2 (like delayed failures at 25 to 50% of the notch-tensile strength in type 4340 steel) was not observed in 212-B, even for irradiated material that had been charged to produce high H_2 contents. Therefore, catastrophic H_2 embrittlement of a well-designed nuclear-reactor pressure vessel is not believed credible. The notch-tensile strength of type 4340 steel was reduced by irradiation, although the tensile strength increased. Catastrophic delayed failure still occurred, but with the sensitivity to hydrogen slightly reduced. (auth)

28793 (BNWL–94) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, February–April 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1965. Contract AT(45-1)-1830. 196p. Dep. CFSTI.

Research is reported on: radiation damage to reactor metals, cladding materials for fast-reactor fuels, radioinduced property changes in structural materials, effects of neutron irradiation on properties of pure iron and other bcc metals, radiation stability of steels, effects of radiation on high-temperature metals and alloys, reactor metals, chemical metallurgy, materials engineering, PRTR pressure tubes, and physical metallurgy. (M.C.G.)

28794 (BNWL–CC–355) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August–October 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1965. Contract AT(45-1)-1830. 176p. Dep. CFSTI.

Developments are reported for studies on: radiation damage in reactor metals; radioinduced property changes in structural materials; fission fragment effects in structural materials; effects of neutron irradiation on properties of pure Fe and other bcc metals; effects of substructure on irradiation stability of ASTM A302B steel; procedures for fracture toughness tests on reactor pressure vessel steels; radiation effects on pressure vessel steels; radiation effects on high temperature metals and alloys; radiation effects on fuel cladding materials; in-reactor measurements of mechanical properties; weld zone fracture toughness determinations; chemical metallurgy; materials engineering; physical metallurgy; and in-pile fatigue testing of reactor structural steels. (P.C.H.)

28795 (BNWL–CC–510) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, November, December 1965–January 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1966. Contract AT(45-1)-1830. 279p. Dep. CFSTI.

Research is reported on radiation damage to reactor metals, radioinduced property changes in structural materials, effects of substructure on irradiation stability of steel, irradiation testing of reactor structural materials, effects of radiation on refractory metals and alloys, radiation metallurgy, reactor metals research, environmental effects, ATR gas loop, and gas loop development. (M.C.G.)

28796 (GA–7661) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report, August 1–October 31, 1966. Trozera, T. A.; Firle, T. E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 31, 1967. Contract AT(04-3)-167. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress of a research program on deformation mechanisms in high-purity bcc metals, caused by neutron irradiation, and in determining the nature of the forces resisting dislocation motion is reported. Details of sample preparation and mechanical-property measurements are given. (P.G.C.)

28797 (GA–7895) A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Quarterly Progress Report No. 8. Trozera, T. A.; Flynn, P. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 12, 1967. Contract AT(04-3)-167. 17p. (EURAEC–1839). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The four ambient temperature irradiation capsules were opened, and temperature and flux monitors were examined. The out-of-cell Charpy impact machine was instrumented, and several successful tests were made. The elevated temperature (290°C) irradiation capsule was assembled, inserted in the LITR, and removed with a fluence of about 9×10^{18} n/cm^2. (auth)

28798 (HW–78760) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, May–July 1963. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 15, 1963. Contract AT(45-1)-1350. 293p. Dep. CFSTI.

Developments are reported for studies on: calibration of impact testing machine; radiation effects on AISI-347 stainless steel; radiation effects on tubes subjected to multiaxial stress distributions; radiation effects on mechanical properties of structural materials; effects of epithermal fissions in ^{235}U when using U as a fast flux monitor; oxidation and corrosion of alloys and metals; radiation damage to reactor components; gas-loop development; damage mechanisms; neutron damage to metals; effects of modifying temperature during irradiation on steels; equipment, techniques, and facilities for irradiation effects studies; radiation effects on high-temperature alloys; radiation-enhanced diffusion in Cu–Al; fission spectrum irradiation facility; in-reactor fatigue

testing of reactor structural steels; and nondestructive testing instrumentation for reactor pressure vessels. (P.C.H.)

28799 (HW-79345) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August-October 1963. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 15, 1963. Contract AT(45-1)-1350. 369p. Dep. CFSTI.

Research progress is reported on: brittle fracture, effects of neutrons on metals and alloys, reactor metals, flux monitoring studies, chemical metallurgy, materials engineering, physical metallurgy, mechanicals, nuclear materials and propulsion, and materials testing. (M.C.G.)

28800 (HW-84618) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, November, December 1964-January 1965. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 15, 1965. Contract AT(45-1)-1350. 31p. Dep. CFSTI.

Research is reported on: radioinduced property changes in structural materials, reactor metals research, chemical metallurgy, materials engineering, physical metallurgy, damage mechanisms, effects of radiation on high-temperature metals and alloys, radiation metallurgy, and radiation effects on steels. (M.C.G.)

28801 (WCAP-3677-3) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Quarterly Progress Report for the Period Ending March 31, 1967. Cochrun, L. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1967. Contract AT(30-1)-3677. 34p. (EURAEC-1829). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Construction and testing of the calibration capsule was completed. Temperature uniformity, with and without gas cooling and resistance heating, was unsatisfactory. The design was modified on the basis of experimental results and a second calibration capsule is to be built and tested. The materials to be used, including a Ni-modified Mn-Mo steel and a European forging grade steel, were fabricated, and tensile properties of both steels were evaluated at -250 to 600°F. (P.C.H.)

28802 ATOMIC DISPLACEMENTS IN IRRADIATED EQUIATOMIC Ag-Au. Kidron, A. (Technion, Haifa, Israel). Phys. Lett., 24A: 644-5(June 5, 1967).

An equiatomic Ag-Au alloy was irradiated with 3 MeV electrons at 50°C. Measurements of the x-ray-diffraction lines and the diffuse scattering were made both before and after the bombardment. The amount of the short range order, as well as the Debye temperatures and atomic displacements, are changed by the irradiation. (auth)

28803 ON THE NATURE OF RECOVERY STAGE III IN IRRADIATED Al. Ceresara, C.; Federighi, T.; Pieragostini, F. Acta Met., 15: 1252-3(July 1967).

Discussions of the nature of Stage III in neutron-irradiated Al are given. It is concluded that quenching experiments furnish a clear evidence that vacancy-type defects can move in Stage III in Al; however, the possibility that interstitials effectively move at the beginning of Stage III can not be excluded. (D.H.M.)

28804 CLUSTERING IN Al-G.P. ZONE ALLOYS AFTER LOW TEMPERATURE IRRADIATION. Sosin, A. (North American Aviation Science Center, Thousand Oaks, Calif.); Garr, K. R. Acta Met., 15: 1250-1(July 1967).

Clustering in an Al-Cu 4% alloy after neutron irradiation at -195°C was examined previously and interpreted in terms of a model in which only vacancies migrated in Stage III. A model in which more than one defect migrates in Al following irradiation in the temperature region generally ascribed to Stage III is discussed. After irradiation of the prequenched alloy, the resistivity was observed to decrease initially. It is proposed that the decrease could be due to interstitial migration. The fact that the initial resistivity decrease occurred in each alloy sample at essentially the same temperature was interpreted to indicate that vacancy migration was important only above 220°K. Experimental data for electron-irradiated samples of Al-Ga, Al-Mg, Al-Ag, and pure Al at 4°K are presented. (D.H.M.)

28805 STUDY OF LENGTH VARIATION OF α PLUTONIUM BY AUTOIRRADIATION AT 4°K. Lallement, R. (CEN, Fontenay-aux-Roses, France); Wigley, D. A. Phys. Status Solidi, 21: 145-50 (May 1, 1967). (In French).

The length increase with time of α Pu was measured at 4.2°K. The length increases according to the following law: $(\Delta L/L) = A[1 - \exp(-\alpha t)]$ with $\alpha = 2.2 \times 10^{-4}$/hr and $A = 2 \times 10^{-2}$. The saturation of length is much slower than the corresponding saturation of resistivity. This difference allows a qualitative explanation of the maximum observed in the variation of the resistivity with time in liquid He. The difference between the two saturation laws shows that the saturation of the resistivity is not linked to the saturation of the production of defects. The isochronal annealing of the defects has shown two stages of recovery, one around 80°K, the other around 160°K. (auth)

28806 DEFECTS IN NEUTRON IRRADIATED MOLYBDENUM. Rao, P.; Thomas, G. (Univ. of California, Berkeley). Contract W-7405-eng-48. Acta Met., 15: 1153-67(July 1967). (UCRL-17249).

Mo of purity 99.965% was examined by transmission electron microscopy and field ion microscopy before and after neutron irradiation to 1×10^{19} nvt at reactor ambient temperature. The structure after 1 hr anneal at 760°C following irradiation was also investigated. Dark field strain contrast analysis showed that the defects induced by irradiation were in the form of small (~100 Å dia, grown to ~200 Å dia after the anneal) perfect prismatic dislocation loops of the {110} a/2 ⟨111⟩ type. The loops were identified, within the limits of strain contrast theory, to be mostly interstitial in character. Field ion micrographs taken of specimens made from foils previously examined by electron microscopy, failed to reveal any vacancies, although images characteristic of interstitials and/or interstitial impurity atoms were obtained. The results are discussed in terms of the known irradiation behavior of Mo. (auth)

28807 EFFECT OF NEUTRON IRRADIATION ON THE ROLLING TEXTURE OF COPPER. Alers, G. A. (Ford Motor Co., Dearborn, Mich.); Choi, S. S.; Liu, Y. C. Trans. Met. Soc. AIME, 239: 917-19(June 1967).

A study was made to determine if neutron irradiation produces a brass-type rolling texture in Cu. There was essentially no difference in the anisotropy of Young's modulus between irradiated and unirradiated Cu. There was no evidence to suggest that neutron irradiation has any effect on the rolling texture of Cu. This implies that lattice defects introduced by neutron irradiation do not affect texture development. (M.C.G.)

28808 THE INFLUENCE OF IRRADIATION TEMPERATURE ON THE DAMAGE STRUCTURE IN NEUTRON-IRRADIATED MOLYBDENUM. Eyre, B. L.; Downey, M. E. (Atomic Energy Research Establishment, Harwell, Eng.). Metal Sci. J., 1: 5-8 (Jan. 1967).

A thin-film electron-microscope study was made of a commercially pure and a zone-refined Mo, neutron-irradiated to a dose of 5×10^{19} n/cm^2 at 60 and 200°C. Visible damage clusters were present in all the specimens, but they were more coarsely distributed in the purer material and after irradiation at the higher temperature. In the case of the zone-refined material irradiated at 200°C the damage was distinguishable as two components: coarsely distributed, irregular dislocation lines and a finer distribution of small dots up to 50 Å in dia. The results of loop analysis on annealed specimens indicated that the small dots are vacancy clusters. Dark-field analysis was carried out on the small clusters, showing asymmetrical contrast in the zone-refined material irradiated at 60 and 200°C. The results indicated that these clusters, at least, are small loops. [See also AERE-R 5269] (auth)

28809 DEISTVIE OBLUCHENIYA NA MATERIALY. VVEDENIE V RADIATSIONNOE MATERIALOVEDENIE. (Radiation Effects on Solids. Introduction to Radiation Material Studies). Konobeevskii, S. T. Moscow, Atomizdat, 1967. 404p.

The effects of radiation on solids are examined in detail. The theory of atomic collisions and experimental methods for irradiation of materials with different forms of radiation (electrons, γ rays, and neutrons) are examined. The structure defects existing and arising under the effects of radiation and their connection with the physical and mechanical properties of the solid are described. The effects of radiation on the mechanical properties and the phase state of alloys are examined. Descriptions of the effects of irradiation on materials used in reactor construction such as U and its alloys, oxides, carbides, steel, and graphite are included. (tr-auth)

Ceramics and Cermets

Corrosion and Erosion

28810 (AECL-2609) LITERATURE SURVEY OF U_3Si CORROSION. Bourns, W. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). July 1965. Reprinted Feb. 1967. 15p. Dep. CFSTI. AECL $0.50.

A review is presented on the correlation between corrosion rate of U_3Si fuel and the Si content. The effects of U_3Si on the corrosion rate of sheathing are also reviewed along with the effects of ternary element additions and irradiation. Unirradiated delta-phase U_3Si has sufficient corrosion resistance over a composition range of 3.6 wt % to 4.0 wt % Si. Few irradiated specimens, and none to high burnup, have been corroded; further testing is required. (25 references). (auth)

Preparation and Fabrication

Refer also to abstracts 27989 and 30289.

28811 (AECL-2675) FABRICATION OF UO_2–PuO_2 AND ThO_2–PuO_2 EXPERIMENTAL FUEL. Jeffs, A. T.; Boucher, R. R.; Norlock, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1967. 17p. (CONF-670306-5). Dep. CFSTI. CAN $0.50.

From IAEA Symposium on Uses of Plutonium as a Reactor Fuel, Brussels, Belgium.

Fabrication procedures are described for preparation of an experimental charge of eleven sintered pellet fuel elements for a pressurized-water test loop in the NRX reactor. Six elements of mechanically mixed UO_2-PuO_2 plus two enriched UO_2 reference elements were fabricated by two alternative routes to permit comparison of performance during operation. The two alternative processes were conventional H_2 sintering at 1600°C and a low-temperature route starting with hyperstoichiometric mixed oxides and using $Ar-10\%H_2$ as the reducing atmosphere. Three elements containing mechanically mixed ThO_2-PuO_2 were fabricated by a conventional high-temperature sintering route to an average pellet density of 9.6 g cm^{-3}. PuO_2 contents for these elements ranged up to 1.93 wt % and all elements were of fuel length (15 cm), clad in Zircaloy-2 of 2.03 cm OD. (auth)

28812 (BAW-3714-1) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 1, July–September 1966. Dewell, E. H. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Mar. 1967. Contract AT(30-1)-3714. 53p. Dep. CFSTI.

Urania gels were contacted with Pu in three valence states (III, IV, VI) in acid nitrate solution (pH approximately 0.5), and the uptake of Pu was measured for periods ranging from a few minutes to several hours. Pu(IV) seemed to be the most promising, since it combines a high uptake (about 20% U/U + Pu) with ease of preparation. However, all $Pu-HNO_3$ solutions are corrosive to UO_2; therefore, gel attrition measurements have received considerable attention. (M.C.G.)

28813 (BNWL-386) COLD PRESSING AND SINTERING OF RARE EARTH OXIDES. Fullam, H. T.; Kirby, L. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

Sm_2O_3 was cold pressed to densities in excess of 80% of theoretical (6.21 g/cm^3) by standard pressing techniques. Strength limitations of the dies and plungers used prevented pressing at pressures above 102 TSI. If better dies were designed so higher pressures could be used, higher cold press densities should be possible. Alternatively, if the Sm_2O_3 was calcined at temperatures above 1500°C, the cold press density should increase. Sinter densities as high as 95.6% of theoretical (7.40 g/cm^3) were obtained with Sm_2O_3 which had been cold pressed to maximum density. The optimum sintering conditions were not determined. (P.C.H.)

28814 (EUR-3467.d) HERSTELLUNG VON URANKARBID, 5,5 PERCENT ANREICHERUNG. Abschlussbericht 15,11,1963–31,3,1965. (Preparation of Uranium Carbide Rods 5,5 Percent Enriched. Final Report, November 15, 1963–March 31, 1965. Himmelstein, P.; Ploeger, F.; Schaefer, L.; Vietzke, H. (Nuclear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)). May 1967. 14p. (In German). Dep.

With regard to the preparation of fuel elements intended for irradiation tests within the framework of the ORGEL project, UC rods enriched at 5.5 wt % of ^{235}U were prepared. The transformation of basic materials into rods of UC consisted of: conversion of the UF_6 to UO_2; transformation of the pellets into UO_2 powders of nuclear purity; mixing all quantities of oxide prepared with graphite, compression of this mixture in the form of pellets, and transformation of the pellets into carbide; melting and casting of the carbide in an arc furnace; analytical control (carbon contents); and packing. (P.C.H.)

28815 (GEMP-516) BEHAVIOR OF URANIA IN A THERMAL GRADIENT AND CONTROL OF URANIA STOICHIOMETRY. Fryxell, R. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). May 17, 1967. Contract AT(40-1)-2847. 13p. Dep. CFSTI.

Thermodynamic criteria for fabricating and maintaining a stoichiometric urania composition at high temperatures are summarized. Above 1500°C, O_2 deficiency may develop, the rate and magnitude depending on temperature, environment, and certain other experimental parameters. If O_2 deficiency does not develop, thermal gradients are without effect on the composition. However, composition gradients will develop under thermal gradient conditions if O_2 deficiency exists. The composition profiles exhibit a linear relationship between log (2.00−O/U) and reciprocal temperature, but the apparent enthalpy is dependent on experimental conditions, with a minimum value of about 24 kcal/mole. (auth)

28816 (NP-16721) SELECCION DEL PROCESO DE SINTERIZACION DEL BIOXIDO DE URANIO MEDIANTE LA DETERMINACION DE LA SUPERFICIE ESPECIFICA. (Selection of the Sintering Process of Uranium Dioxide by Determining its Specific Surface). Moreno, Alberto Pecina (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1964. 102p. (In Spanish). Dep.

Thesis.

Different procedures for the fabrication of UO_2 for nuclear fuels are outlined with emphasis on the sintering procedure. The importance of determination of the specific surface in an evaluation of the sintering procedure to be used is shown. The theoretical bases for the BET method are given and the Innes modification is outlined. A device constructed for the Innes modification of the BET method is described in detail. (J.S.R.)

28817 (ORNL-TM-1782) UO_2–ThO_2 AND UO_2–ThO_2 SOLS PREPARED BY PRECIPITATION–PEPTIZATION PROCESSES. Meservey, A. B. (Oak Ridge National Lab., Tenn.). Mar. 20, 1967. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Coprecipitation methods were used for the preparation of mixed thoria-urania sols, as possible alternates to solvent extraction methods. Exceptionally stable sols (>18 mo.) resulted from the coprecipitation of Th and U(IV) hydroxides in Th/U ratios of 1/1 and 3.5/1. Satisfactory microspheres were formed and calcined from one of these sols. A new coprecipitation method was developed for preparing 3 Th/1 U mole ratio sols using hexavalent U, featuring the attainment of low nitrate-to-metal ratios by a seed sol technique. The sols readily formed noncracking microspheres in 2-ethyl-1-hexanol by the conventional ORNL method and were fired to 99.5% of theoretical density and less than 1% porosity. (auth)

28818 (WAPD-TM-578) FABRICATION OF SOLID, ANNULAR, AND DISHED-END CERAMIC FUEL PELLETS. Johnson, R. G. R.; Crain, H. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT(11-1)-Gen-14. 88p. Dep. CFSTI.

An investigation was performed as part of the LSBR fuel development program to determine process parameters for the production of cylindrical seed and blanket (ThO_2) fuel pellets by dry pressing and sintering. A double-firing technique was used to ensure complete U homogeneity in the finished seed pellets. After the first firing (calcination of the raw powders to form solid solutions), the resulting oxide "cake" was comminuted in a fluid energy mill to a highly sinterable, micron-sized powder. Pellets were fabricated by conventional dry pressing of an agglomerated powder containing a wax binder. Green pellets were densified by a high-temperature H_2 sinter. Fuel types investigated included two UO_2-ZrO_2 compositions (28 and 36 wt % UO_2), two UO_2-ThO_2 compositions (7.6 and 21 wt % UO_2), 7.5 wt % UO_2–6.7 wt % $CaO-ZrO_2$, and plain ThO_2. The results demonstrated the feasibility of fabricating these compositions of ceramic fuel into pellets by the processes employed. (auth)

28819 ANODIC TANTALUM OXIDE DIELECTRICS PREPARED FROM BODY-CENTERED-CUBIC TANTALUM AND BETA-TANTALUM FILMS. Vratny, F. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Vromen, B. H.; Harendza-Harinxma, Alfred J. Electrochem. Technol., 5: 283-7(May-June 1967).

Improved thin film dielectrics were prepared from anodic tantalum oxide films prepared from sputtered β-Ta films. Beta-Ta is a high-resistivity material with a tetragonal structure, which can be obtained by sputtering, evaporation, or chemical vapor deposition. Anodic oxide films prepared from this material have better leakage and are more stable on accelerated aging than those prepared on body-centered-cubic (bcc)-Ta. These results were demonstrated for both bcc and $\beta-Ta$ films prepared by diode and substrate bias cathodic sputtering in batch systems, and for films prepared by diode sputtering in a continuous in-line machine. The failure of bcc-Ta to produce high-quality, thin film dielectrics is due predominantly to poor adherence and mechanical instability of the metallic film. (auth)

28820 LOW-DENSITY PYROLYTIC-CARBON COATINGS FOR NUCLEAR FUEL PARTICLES. Beutler, H.; Beatty, R. L.; Coobs, J. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Electrochem. Technol., 5: 189-94(May-June 1967). (ORNL-P-2442).

Conditions for depositing pyrolytic-C coatings on ceramic fuel particles in a fluidized bed by the pyrolysis of acetylene are presented. Coatings having densities as low as 0.6 g/cm^3 and accessible porosity as great as 65% were deposited on 200- to 500-μ-dia microspheres of ceramic fuels. These low-density coatings withstand up to 35% deformation under diametral loading with fracture. (auth)

28821 DEFORMATION OF POLYCRYSTALLINE TRANSITION METAL CARBIDES. Kelly, A.; Rowcliffe, D. J. (Cambridge Univ., Eng.). J. Amer. Ceram. Soc., 50: 253-6(May 21, 1967).

Plastic deformation was studied in hot-pressed polycrystalline specimens of TiC, VC, NbC, TaC, and WC tested in four-point bending and under compression to 2100°C. Transition from brittle to ductile behavior occurred at approximately half the absolute melting temperature for each material. Above this temperature the yield strengths decreased exponentially with increasing temperature. Between the ductile-brittle transition temperature and about 1900°C the apparent activation energy for flow in the carbides with the rock-salt structure was near 0.5 eV/atom. Above 1900°C the value was approximately 2 eV/atom; the value for WC was apparently 0.3 eV/atom to 2070°C. VC and TiC recovered extensively on annealing for short times near 2000°C. No such recovery occurred in WC under these conditions. The results for polycrystalline carbides were compared with available data for single crystals of TiC. (auth)

28822 IMPROVEMENTS IN OR RELATING TO SINTERED BODIES. Livey, David Thomas; O'Neill, John Sidney (to United Kingdom Atomic Energy Authority). British Patent 1,061,467. Mar. 15, 1967. Filed June 24, 1964.

Density and strength of sintered BeO bodies were increased by mixing 1 to 10 wt % of sub-micron sized SiC or SiN (to restrict grain growth) with the BeO powders before shaping and sintering. (P.G.C.)

28823 METHOD OF PREPARATION OF NUCLEAR FUEL MATERIAL AND PRODUCTS THUS OBTAINED. Anselin, Francois; Pascard, Roger (to CEA). British Patent 1,064,224. Apr. 5, 1967. Priority date Nov. 5, 1963, France.

Nuclear reactor fuels, having a Pu and U base are prepared by mixing PuN, C, and UH_3 in suitable proportions, heating to form UC, and sintering the resulting mixture of PuN and UC under 2000 to 15,000 bars at 1200 to 1700°C. Preparation may be carried out in a single stage after addition of 1 wt % of naphthalene and 0.5 wt % Ni, at 1200 to 1700°C, 2000 to 10,000 for 2 to 6 hours. Greater homogeneity may be obtained by pelletizing the mixture, heating in vacuum, grinding the sintered pellets, repelletizing, and firing at 1200 to 1500°C under pressure in the range of 10^{-5} to 10^{-6} mm Hg for 2 to 6 hours. Fuel materials prepared by the foregoing method have a density of 12.4 to 13.0 g per cm^3. The sintered pellets may be annealed at 1600°C for 2 to 6 hours to further increase the density. (P.G.C.)

28824 YADERNYI GRAFiT. (Nuclear Graphite). Vyatkin, S. E.; Deev, A. N.; Nagornyi, V. G.; Ostrovskii, V. S.; Sigarev, A. M.; Sokker, G. A. Moscow, Atomizdat, 1967. 280p.

Generalized data on the methods for the production and on properties of artificial graphite, widely used as construction material of numerous different details and aggregates in nuclear reactors, are reported. The technology of the production of artificial graphite for nuclear moderators is described. The crystal and porous structure of nuclear graphite, its electron, thermodynamic, thermal, and mechanical properties, and the interaction of graphite with some elements and compounds are described. The methods for the production of graphite of different quality with increased density and reduced porosity are reported and their properties described. The behavior of graphite in reactors is discussed. New forms of graphite materials and forms existing abroad for reactor moderators are described. (tr-auth)

Properties Evaluations

Refer also to abstracts 28824 and 29358.

28825 (BLG-364) CRITICAL DESIGN CONSIDERATIONS FOR IN-PILE THERMAL CONDUCTIVITY EXPERIMENTS ON UO_2. Pech, P. K.; Mestdagh, G. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Nov. 1965. 45p. Dep.

Methods used to determine the thermal conductivity of sintered UO_2 fuel elements are reviewed. It was found that up to about 1500°C the agreement of various results obtained on sintered, 95% dense UO_2 is good. The controversy over radiation and electronic contributions to the conductivity at higher temperatures is as yet unresolved. Thermal conductivity of UO_2 decreases with increasing O/U ratio and increases with decreasing O/U ratio. Results on swaged, extruded, or vibrationally compacted fuels are discussed briefly. (67 references). (P.C.H.)

28826 (CEA-R-3201) ETUDES DE COMPOSES U-Pu-C-Ti. (Studies of U-Pu-C-Ti Compounds). Milet, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1967. 44p. (In French). Dep.

The U-Pu-C-Ti compounds (5 to 20 at. % Ti) were to effect improvements in properties of U-Pu-C carbides and to extend the existence field of the (U, Pu)C phase. The Pu/(U + Pu) ratio was fixed to 15%. All the alloys were elaborated and cast in an arc furnace. A two-phase field (U, Pu)C + TiC exists which permits the avoidance of di- and sesquicarbides and the (U, Pu) phase. A eutectic between (U, Pu)C and TiC was found around 15 at. % Ti. Practically all of the Ti was in TiC form, Ti solubility in (U, Pu)C being less than 1 at. %. The most promising alloys were those containing two phases: (U, Pu)C + TiC. In comparison with the U, Pu)C phase, Ti addition did not change the thermal expansion coefficients nor the thermal cycling behavior very much between 160 and 1000°C which was excellent. On the other hand atmospheric corrosion behavior was improved; compatibility with stainless steel was better; and thermal conductivity, calculated from electrical resistivity was enhanced. (auth)

28827 (WANL-TNR-205) DIFFUSION OF CARBON IN TANTALUM CARBIDES. Brizes, W. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Mar. 1967. Contract SNP-1. 11p. Dep. CFSTI.

The chemical diffusivity of C in TaC and Ta_2C was investigated as a function of temperature from 2100 to 2650°C. The diffusivities determined were found to be in good agreement with the results of others. Experimental evidence is presented however, indicating that the diffusivity of C in TaC is not constant across the stoichiometric range of TaC and may vary by an order of magnitude or more. (P.C.H.)

28828 (WAPD-TM-586(Rev.)) THERMAL CONDUCTIVITY OF BULK OXIDE FUELS. Belle, J.; Berman, R. M.; Bourgeois, W. F.; Cohen, I.; Daniel, R. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1967. Contract AT(11-1)-Gen-14. 99p. Dep. CFSTI.

Data are reported on the thermal conductivity of the oxide fuels ThO_2, ThO_2-UO_2, ZrO_2-UO_2, ZrO_2-UO_2-CaO, and UO_2 prepared by various ceramic fabrication techniques. The thermal conductivity of low-density bodies was found to be highly dependent on the fabrication technique and, therefore, resulting pore structure; a computer simulation of porous bodies was successful in reproducing the measured sensitivity to pore shape. Factors affecting the thermal conductivity of irradiated fuel bodies are reviewed, and a relation between conductivity, porosity, depletion level, and temperature is proposed for various oxide fuels. (auth)

28829 COMPLEX STUDIES OF HEATING EFFECTS ON THE MIXTURE OF ZIRCONIUM DIOXIDE WITH CALCIUM CARBONATE. Bessonov, A. F.; Shalaginov, V. N.; Taksis, G. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 2003-6(Nov. 1966). (In Russian).

Heating effects on ZrO_2 and mixed ZrO_2 were studied using a specially designed complex installation for simultaneous measurement of electric conductivity, changes of linear dimensions, and x-ray and thermographic analysis. The scheme of the installation is included. (R.V.J.)

28830 MICROHARDNESS OF SOME OXIDES. Bazhenova, L. N.; Ivan'ko, A. A.; Samsonov, G. V.; Slyshankova, V. A. (Kiev Polytechnic Inst.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1991-7(Nov. 1966). (In Russian).

The microhardness of a series of oxides has been tested with various indenter loads (30 to 200 g) applied for various lengths of time. It was found that the microhardness of oxides decreases with increased load and increased test duration. The average microhardness (kg/mm^2) was as follows: Al_2O_3-2540; MgO-1015; CaO-615; TiO_2-1085; ZrO_2-1230; HfO_2-925; Nb_2O_5-740; Cr_2O_3-2970. It is believed that the hardness of the oxides depends on the probability of metal and O atoms forming stable electron configurations. As the number of stable configurations formed by one or both of the components drops, the number of free electrons increases and the hardness also drops. (ATD)

28831 STRESS DEPENDENCE OF THE CREEP RATE OF TWO COMMERCIAL GRAPHITES. Green, W. V.; Zukas, E. G. (Los Alamos Scientific Lab., N. Mex.). Electrochem. Technol., 5: 203-6(May-June 1967).

The stress dependence of the creep rate of two commercial graphites was measured by a changing-stress method at 2300 and 2500°C. In this way, the structural differences that normally complicate the analysis of results from several different samples were eliminated. The creep rate was found to be proportional to the five-and-one-half power of stress. It was concluded that stress-directed diffusion creep was not the rate-controlling process, but a dislocation mechanism was more probable. (auth)

28832 FORMULATION AND RAW MATERIALS EFFECTS ON THE HIGH-TEMPERATURE PROPERTIES OF GRAPHITE. Ole-

sen, Niels C.; Fair, Frank V. (Speer Carbon Co., Niagara Falls, N. Y.). Electrochem. Technol., 5: 194-203(May-June 1967).

The effects of raw material and grit size on the high-temperature properties of graphite are discussed. At 1500°C, strength increases to twice the room-temperature value; static modulus of elasticity increases, goes through a maximum, and then decreases as high-temperature creep becomes effective. Discussions offer methods for limited control of these high-temperature properties of various grades of graphite by heat treatment and formulation. (P.C.S.)

28833 COMPLEX METHOD FOR HIGH-TEMPERATURE ANALYSIS OF THE α–UO_3 DISINTEGRATION PROCESS. Bessonov, A. F.; Shalaginov, V. N.; Vlasov, V. G.; Taksis, G. A. Zh. Priki. Khim., 40: 1128-30(May 1967). (In Russian).

A high-temperature device capable of recording data on electric resistance, thermal effects, dimensional changes, and x-ray diffraction data was used in the investigation of α-UO_3 disintegration in the air. The data showed that the α-UO_3 transition into U_3O_8 formed a continuous series of solid solutions at 510 to 630°C. The orthorhombic mixed oxides did not exhibit any appreciable changes on further heating in the air up to 1200°C. (R.V.J.)

28834 PREPARATION AND CHARACTERIZATION OF ZrO_2 AND HfO_2 MICROBALLOONS. Gilman, William S. (Mound Lab., Miamisburg, Ohio). Amer. Ceram. Soc. Bull., 46: 593-5(June 1967). (MLM-1369J).

Microballoons of ZrO_2 and HfO_2, 0.15 to greater than 0.5 mm in dia, were produced by passing the respective microspheres through a N-enriched plasma of an induction-coupled plasma torch. Microspheres of PuO_2, ThO_2, UO_2, CeO_2, TiO_2, Al_2O_3, and La_2O_3 did not balloon in this plasma environment. Properties of the ZrO_2 and HfO_2 microballoons were studied and results are reported. (auth)

Structure and Phase Studies

Refer also to abstracts 28778 and 29350.

28835 (BM-RI-6968) PHASE RELATIONS IN THE URANIUM MONOCARBIDE REGION OF THE SYSTEM URANIUM–CARBON–OXYGEN AT 1,700°C. Henry, Jack L.; Paulson, Danton, L.; Blickensderfer, Robert; Kelly, Hal J. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). July 1966. 48p. Dep. CFSTI.

The monocarbide region of the ternary system U–C–O was investigated at 1,700°C as the first phase of a more extensive study of a portion of the four-component system U–C–O–N. An area bounded by the following compositional limits in atomic percent was studied: U, 44 to 55; C, 30 to 60; O, 0.2 to 20. Compacts composed of mixtures of U, graphite, and UO_2 powders were sintered at 1,700°C under an equilibrium pressure of CO to produce UOC specimens having a variety of compositions. Sintered specimens were evaluated by x-ray, chemical analysis, and ceramographic techniques. Solid-solution boundaries and phase relations were established, and the effects of composition on the lattice parameter as well as the decomposition pressure were investigated. O can be substituted for C in stoichiometric UC to the extent of about 17 at. % at 1,700°C. The composition range of the oxycarbide solid solution extends from about 48 to 51 at. % U in the low O region. Above 10 at. % O the composition range narrows to less than 1 at. % U. CO exists as a gaseous phase in equilibrium with all compositions that contain O. Five separate phase fields were found bounding the solid-solution area. Other phases within this portion of the system include U, UO_2, UC_2, and U_2C_3. Decomposition pressures of oxycarbide compositions at 1,700°C were found to vary from a few microns for stoichiometric and U-rich compositions to 35 torr for C–O-rich specimens. Lattice parameters were found to depend on the U to C + O ratio as well as on the extent of substitution of O into the stoichiometric UC lattice. (auth)

28836 (GEAP-4689) GRAIN GROWTH OF UO_2. PART II. Hausner, H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1965. Contract AT(04-3)-189. 26p. (EURAEC-1836). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The influence of different fabrication procedures on the grain growth of UO_2 was studied at 1900 to 2300°C. The various methods of fabrication produced different initial grain sizes and different initial densities in the sintered pellets under study. A decreasing time constant, n, was found when impurities were introduced during fabrication by ball milling. The activation energy for grain growth showed different values when different fabrication procedures were applied to the same batch of UO_2. However, the differences are small, so that the uncertainty associated with each value makes it difficult to establish the trend in the temperature dependence with increasing amount of impurities. Large differences in the time constant, n, and the activation energy, Q, were observed when different batches of powder and different fabrication procedures were used. (auth)

28837 (KFK-543) PHASENBEZIEHUNGEN, HERSTELLUNG UND EIGENSCHAFTEN VON UNTERSTOECHIOMETRISCHEM, OXIDISCHEM KERNBRENNSTOFF (UO_{2-x} UND $(UPu)O_{2-x}$). (Phase Relations, Production, and Characteristics of Substoichiometric Oxide Fuels (UO_{2-x} and $(UPu)O_{2-x}$). Thuemmler, F.; Theisen, R.; Patrussi, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Feb. 1967. 44p. (In German). Dep.

The concept of a substoichiometric oxide nuclear fuel material is discussed on the basis of the literature and specific results. The phase regions of UO_{2-x}, PuO_{2-x}, and $(UPu)O_{2-x}$ are described. For the usual Pu content there does not exist, even at low temperatures, the danger of metallic U or Pu precipitation. In pure UO_2 this danger is present however. The problems of preparation appear technically soluble both for pellets and for vibration powder of $(UPu)O_{2-x}$. The compatibility with cladding materials was improved for single-phase (metal-free) substoichiometric products as shown by some examples with CeO_2 instead of PuO_2. The thermal conductivity increased at least up to 1,200 to 1,500°C. The improved thermal conductivity is of value in practical radiation research. (tr-auth).

28838 (TUBIK-2) METHODEN ZUR BERECHNUNG VON SCHMELZDIAGRAMMEN BINAERER OXID-SYSTEME. (Method for the Calculation of Phase Diagrams of Binary Oxide Systems). Reichelt, Wolfgang; Gross, Bodo (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). Nov. 1966. 94p. (In German). Dep.

Previously known possibilities for calculation of fusion diagrams of binary oxide systems from general thermodynamic data are indicated and various methods were used for the calculation of such diagrams. High-melting oxides and two substances, UO_2 and BeO, important in nuclear technical problems were considered. The agreement obtained between the measured and calculated phase diagrams depends on the accuracy of the thermodynamic data underlying the calculations and on the experimentally determined diagrams. (tr-auth).

28839 MOLYBDENUM–COBALT–BORON SYSTEM. Kuz'ma, Yu. B.; Nych, O. V.; Skolozdra, R. V. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1975-9(Nov. 1966). (In Russian).

Experiments have been made to determine the phase equilibria in the Mo–Co–B system and the crystal structure of the Mo–Co–B ternary compounds. A series of Mo–Co–B alloys were prepared from component powders by cold compacting and vacuum sintering at 1500°C. Alloys containing more than 50 at. % B were then remelted in a nonconsummable electrode arc furnace. On the basis of the results of physiochemical analyses, the isothermal section of the Mo–Co–B system at 800°C was plotted. Five ternary phases were indentified in the system at the temperature investigated: a $Mo_2Co_{21}B_6$ compound (the τ-phase) with a cubic lattice of the $W_2Cr_{21}C_6$ type; an x-phase with a composition close to that of $MoCo_4B$ compound and with an undetermined structure; a Mo_2CoB_2 compound characterized by the Mo_2NiB_2-type rhombic structure; a $(Mo_1Co)B$ phase (a cobalt-stabilized high-temperature modification of MoB) with the CrB-type rhombic structure with the lattice parameters almost identical with those of the MoB phase; a $MoCo_2B_4$ compound with a rhombic structure of the Ta_2B_4 type. At the $MoCo_2B_4$ composition, a ternary compound was identified which was in equilibrium with Mo_2B_5 and CoB binary compounds and a $(Mo_1Co)B$ ternary phase. (ATD)

28840 PHASE DIAGRAM OF THE PRASEODYMIUM–SELENIUM SYSTEM. Kalitin, V. I.; Yarembash, E. N.; Luzhnaya, N. P. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1930-8(Nov. 1966). (In Russian).

A table of literature data on the properties of the known praseodymium selenides is presented. An experimental investigation was made on powder form and fused preparations of praseodymium selenides, the composition of which varied from 0 to 100 at. % Se, as well as of single crystals obtained by various methods. For determination of the phase diagram, thermal, x-ray, and microstructural analyses were used. The study resulted in the determination of the formation of six individual chemical compounds: PrSe, Pr_5Se_6, $Pr_{3-x}Se_4$, Pr_4Se_{7+x}, $PrSe_{1.5-x}$, and Pr_2Se_{3+x}. The regions of their homogeneity were established. Following x ray structural analysis of monocrystalline and polycrystalline samples, proposed structures were given for the above compounds and their lattice constants were determined. (ATD)

28841 EFFECT OF ADDITIONS OF GERMANIUM DIOXIDE AND YTTRIUM AND NEODYMIUM GERMATES ON THE POLYMORPHISM OF ZIRCONIUM DIOXIDE. Davtyan, I. A.; Keler,

E. K.; Glushkova, V. B. (Inst. of Chemistry of Silicates, Leningrad). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1998-2002(Nov. 1966). (In Russian).

The following questions are considered: 1) the formation of solid solutions based on ZrO_2 with additions of GeO_2; 2) the stability of these solid solutions and the volatility of GeO_2 from them; and, 3) the effect of the amount of the additions of GeO_2 in a solid solution on the temperature of the monoclinic-tetragonal transition of ZrO_2, and the possibility of the tetragonal form of ZrO_2. Solid solutions of Zr with additions of 2, 5, 10, 15, and 20 mole % GeO_2 were prepared by the method of coprecipitation. In all the mixtures there was observed an exothermic effect of crystallization, and at the same time the crystallization temperature of the product increased with an increase in the amount of additive. X-ray analysis of the products indicated that additions of GeO_2 stabilize the tetragonal form of ZrO_2 only up to a temperature of 1200°C. Therefore, further experiments were undertaken with additions of GeO_2 plus oxides of rare earth elements (Y or Nd) (since oxides of the rare earth elements stabilize ZrO_2 at high temperatures). It was found that stabilization of ZrO_2 with yttrium germanates makes it possible to increase the stability of the solid solutions at high temperatures. (ATD)

28842 PHASE DIAGRAMS OF $Nd_2(WO_4)_3$–$SrWO_4$ AND $NaNd(WO_4)_2$–$SrWO_4$. Rode, E. Ya.; Karpov, V. N.; Eliseev, A. A. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 2007-9(Nov. 1966). (In Russian).

Constitution diagrams of $NaNd(WO_4)_2$–$SrWO_4$ and $Nd_2(WO_4)_3$–$SrWO_4$ systems were constructed. Thermal and x-ray phase analysis showed that the initial components of these systems form continuous series of solid solutions. (R.V.J.)

28843 STRUCTURE AND DIELECTRIC PROPERTIES OF SOLID SOLUTIONS IN THE $PbLi_{\frac{1}{2}}Nb_{\frac{1}{2}}W_{\frac{1}{2}}O_3$–$Pb_2CdWO_6$ SYSTEM. Didkovskaya, O. S.; Klimov, V. V.; Venevtsev, Yu. N. (Inst. of Chemical Reagents and Pure Chemicals, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 2010-14(Nov. 1966). (In Russian).

The $PbLi_{\frac{1}{2}}Nb_{\frac{1}{2}}W_{\frac{1}{2}}O_3$–$Pb_2CdWO_6$ system formed a continuous series of solid solutions with perovskite type structure. Phase transitions followed a certain sequence forming pseudoisometric I, pseudoisometric II, pseudomonoclinic I, and pseudomonoclinic II modifications. Sharp changes in elementary cell parameters were observed during the transition from one modification to the other. The Curie temperature of the solid solutions increased with the content of Pb_2CdWO_6 from 120°C for $PbLi_{\frac{1}{2}}Nb_{\frac{1}{2}}W_{\frac{1}{2}}O_3$ to 410°C for Pb_2CdWO_6. (R.V.J.)

28844 X-RAY STUDY ON A PHASE TRANSITION OF U_4O_9. Naito, K. (Japan Atomic Energy Research Inst., Tokyo); Ishii, T.; Hamaguchi, Y.; Oshima, K. Solid State Commun., 5: 349-52 (May 1967).

Some features of the phase transition of U_4O_9 were investigated by means of X-ray diffractometry. The transition temperature varies from 65 to 96°C, with O/U ratios, and, at the transition, a notable increase in the intensity of superlattice reflection of U_4O_{9-y} with temperature was observed. (auth)

28845 NONSTOICHIOMETRY OF ZrO_2 AND ITS RELATION TO TETRAGONAL-CUBIC INVERSION IN ZrO_2. Ruh, Robert; Garrett, Harold J. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). J. Amer. Ceram. Soc., 50: 257-61 (May 21, 1967).

The system Zr–O was studied in the composition range 50 to 66.7 at. % O by metallographic analysis, high-temperature x-ray analysis, and lattice-parameter determinations at room temperature. The solubility of Zr in ZrO_2 was determined at 1200 to 2000°C, and the cubic-tetragonal inversion temperature of ZrO_2 was shown to be lowered to approximately 1490°C for samples containing α-Zr and oxide phase. Alpha-Zr has greater solubility in the cubic phase than in the tetragonal phase, and the inversion is revealed, in samples quenched from the cubic field, by the exsolution of α-Zr, which is metallographically characterized as striations. At room temperature, the striations are oriented with the 111 and $11\bar{1}$ planes of monoclinic ZrO_2. (auth)

28846 LOWER-TEMPERATURE MODIFICATIONS OF Nb_2C AND V_2C. Rudy, Erwin; Brukl, Charles E. (Aerojet-General Corp., Sacramento, Calif.). J. Amer. Ceram. Soc., 50: 265-8 (May 21, 1967).

The orthorhombic, low-temperature α-modification of Nb_2C has a structure similar to that of ζ-Fe_2N(a = 12.36 A, b = 10.89$_5$ A, c = 4.96$_5$ A) and transforms at ~1200°C into the hexagonal ϵ-Fe_2N type. A second transition at approximately 2500°C is associated with the destruction of long range order in the carbon sublattice. Alpha-divanadium carbide (orthorhombic, a = 11.49 A, b = 10.06 A, c = 4.55 A) is isostructural with α-Nb_2C and transforms at ~800°C into the hexagonal high-temperature modification. The structures of α-V_2C and α-Nb_2C are distorted modifications related to the ϵ-Fe_2N type. (auth)

28847 STUDY OF PHASE TRANSITION IN NbO_2. Sakata, T.; Sakata, K.; Nishida, I. (National Research Inst. for Metals, Tokyo). Phys. Status Solidi, 20: K155-7(Apr. 1, 1967).

X-ray powder diffraction of NbO_2 was carried out at room temperature, 800, 850, 900, 1000, and 1100°C. The diffraction patterns up to 850°C show both the basic rutile type structure and a superstructure, while at 900°C and above only the rutile structure is shown. The rutile unit-cell dimensions and volume are listed for each temperature; the discontinuity temperature of the expansion coefficient is ~800°C. The possible dissociation of Nb–Nb pair bonds in the phase transition is suggested. (D.L.C.)

28848 NEUTRON-DIFFRACTION STUDIES ON TITANIUM–CARBON AND ZIRCONIUM–CARBON ALLOYS. Goretzki, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi, 20: K141-3(Apr. 1, 1967).

In neutron-diffraction studies of the Ti–C system, face-centered cubic superstructure lines were found in the concentration range between 32 and 36 at. % C. The phase was found to be stable up to 1900°C at a concentration of 33 at. % C. Specimens with C concentrations between 36 and 40 at. % showed the same superstructure lines after annealing in H_2 at 700°C. The isotype ordering phase could be found in the Zr–C systems where it appeared near the boundary of the B1 phase. (A.G.W.)

28849 STRUCTURE INVESTIGATIONS OF TWO URANIUM NITRIDES U_2N_{3+x}. Tobisch, J. (Technische Univ., Dresden); Hase, W. Phys. Status Solidi, 21: K11-12(May 1, 1967).

Two powder forms $UN_{1.55\pm0.02}$ and $UN_{1.74\pm0.03}$ were studied using x-ray and thermal neutron diffraction. The peaks can be explained on the basis of the C-type structure of sesquioxides, if the parameters u, x, y, z, and v (U atoms in 24d, N atoms in 48e, and excess N atoms in 16c positions) are assigned values. Interatomic distances were calculated for $UN_{1.55}$. Neutron diffraction on $UN_{1.55}$ at 27°K failed to show a magnetic ordering. (D.L.C.)

28850 PHASE STUDIES OF OXIDES $U_3O_{8\pm x}$ AND $U_8O_{21\pm x}$. Kovba, L. M. Radiokhimiya, 9: 134-6(1967). (In Russian).

The phase composition of uranium oxide in the interval from $UO_{2.57}$ to $UO_{2.67}$ subjected to different thermal treatments was investigated and the presence of a two-phase region in the interval from $UO_{2.600}$ to $UO_{2.615}$ was established. It was established that the lower boundary of the homogeneity range of the oxide $U_8O_{21\pm x}$ does not depend on the temperature and corresponds to the composition $UO_{2.615}$. (tr-auth)

28851 EVIDENCE FOR ZETA Fe_2N-TYPE SUBLATTICE ORDER IN W_2C AT INTERMEDIATE TEMPERATURES. Rudy, Erwin; Windisch, St. (Aerojet-General Corp., Sacramento, Calif.). J. Amer. Ceram. Soc., 50: 272-3(May 21, 1967).

Phase relations in the W–C system were studied at 2000, 2200, 2400, and 2600°C to determine whether ordered types of W_2C other than CdJ_2 antitype occur in the intermediate temperature range. Powder-diffraction patterns of all specimens quenched from 2000°C were indexed on the basis of the hexagonal close-packed unit cell previously reported for W_2C; however x-ray patterns of all specimens quenched from higher temperatures revealed a splitting of certain diffraction lines; the reflections were somewhat diffuse in the alloy series quenched from 2650°C, but were very sharp in the series quenched from 2200 and 2400°C. Excellent agreement between the observed and calculated reflections were obtained by indexing the patterns on the basis of an orthorhombic unit cell analogous to that of the order structure of Mo_2C. Evidence showed W_2C exists in three forms which can not be considered distinct phases, but merely different states separated by homogeneous transitions of the second order. (P.C.S.)

28852 STRUCTURAL FEATURES OF PYROLYTIC GRAPHITE. Hirai, T.; Yajima, S. (Tohoku Univ., Sendai). J. Mater. Sci., 2: 18-27(1967).

The structure of pyrolytic graphite was examined in samples deposited on substrates under various conditions at 1340 to 2310°C and 5 to 200 torr by means of an x-ray technique. The structural features investigated include interlayer spacing, ordering, preferred orientation, intercrystallite porosity, and crystallite size. These features are closely related to the microstructure and density. In particular, the temperature dependence of crystallite size explains three types of formation mechanism, the cause of the occurrence of a minimum density at a certain temperature, and the cause of a preferred orientation in pyrolytic graphite. (auth)

28853 $BeO.Al_2O_3.SiO_2$ SYSTEM: STRUCTURAL RELATIONSHIPS OF CRYSTALLINE, GLASSY, AND MOLTEN BERYL. Riebling, E. F.; Duke, D. A. (Corning Glass Works, Corning, N. Y.). J. Mater. Sci., 2: 33-9(1967).

Physical property measurements are reported for beryl glass

and for three 60 mole % SiO_2 melts (including beryl) at temperatures above 1600°C. Electron micrographic evidence showed that beryl glass underwent a two-liquid phase separation. Density measurements of this glass and its melt can be interpreted in terms of the dissociation of $Si_6O_{18}^{12}$ rings as beryl melts incongruently. The presence of discrete BeO_4 tetrahedra and AlO_6 octahedra in molten beryl is suggested by the electrical conductance and viscosity data for these melts. (auth)

28854 REORIENTATION EFFECTS IN VITREOUS CARBON AND PYROLYTIC GRAPHITE. Lewis, J. C.; Floyd, I. J. (Plessey Co., Ltd., Caswell, Eng.). J. Mater. Sci., 1: 154-9 (May 1966).

In a study of the gaseous oxidation of C at high temperatures, preheating experiments were carried out to determine to what extent the reactivity of a specimen was dependent upon its immediate thermal history. Tubular specimens of vitreous C and of pyrolytic graphite, heated in N_2 or He for several minutes at 2850 to 3100°K by rf induction, developed a skin of crystalline C, nodular in appearance and apparently growing into the C from the surface. The vitreous C was isotropic, with no preferred orientation of crystallites; pyrolytic graphite had a preferred orientation of basal planes at right angles to the axis of the specimen, so that curved surfaces were composed predominantly of edge atoms. X-ray diffraction studies of the skin indicated that it was partially graphitized and strongly orientated with basal planes parallel to the surface. The mechanism of the reorientation process is not yet clear, but the driving force may be a change in surface free energy. This energy of the basal plane is lower than that of a surface consisting partly or almost entirely of edge atoms (as in vitreous C and pyrolytic graphite) of the orientation used, respectively. (BBB)

28855 X-RADIOGRAPHIC DETECTION OF CUBIC TUNGSTEN CARBIDE CRYSTALS IN SPARK-ETCHED SOLID METAL AND IN PURE SMELTED TUNGSTEN CARBIDE. Krainer, E.; Robitsch, J. Planseeber. Pulvermet., 15: No. 1, 46-56(Apr. 1967). (In German).

Spark machining of different cemented carbides caused a strong increase in the cubic carbide solid-solution phase and a decrease in the lattice constants. The doubtful high-temperature modification of WC could be detected and measured by x-ray diffraction and identified as β-WC_{1-x} in the surface of spark-eroded Ti-free cemented carbides are pure fused W carbides. The lattice constant was 4.248 Å ± 1 mA, the structure type B1, fcc, O_h^5-Fm3m. Spark erosion appears to be the simplest and most effective method for producing and preserving unstable high-temperature phases, at least together with other phases. (auth)

28856 RECRYSTALLIZATION AND KINETICS OF Ni-TD. Bassi, A. (CISE, Milan); Camona, G.; Conserva, M.; Fiorini, P. Met. Ital., 59: 239-46(Apr. 1967). (In Italian).

The effects exerted by dispersed ThO_2 particles in recrystallization was investigated to explain the causes of the difference in behavior of Ni-TD to nickel. Hardness measurements were performed on nickel and compared with Ni-2.5% ThO_2, whose dispersion parameters were calculated after isothermal annealing at various temperatures on 90% rolled samples to determine the activation energies of the recrystallization process. Recrystallization curves after isochronous annealings on differently rolled samples were drawn using x-ray diffraction data. The data thus obtained were interpreted by means of the structural phenomena on which the recrystallization process of Ni-TD observed by direct-transmission electron microscopy is based. (auth)

28857 EPR OBSERVATION OF Z-TYPE CENTRES IN ALKALI HALIDE CRYSTALS DOPED WITH Mn^{++}. Bettica, P.; Santucci, S.; Stefanini, A. (Univ., Pisa, Italy. CNR, Pisa, Italy). Nuovo Cim. (10), 48B: 316-25(Apr. 11, 1967).

Studies of x-irradiated NaCl(Mn^{++}) and KCl(Mn^{++}) single crystals which have undergone the treatment giving rise to Z-bands in the same crystals when doped with alkaline-earth ions are reported. A new six-line EPR spectrum, (a), has been found, which has central symmetry. At 100°C crystals showing the (a) spectrum reveal a second 90-line axial-symmetry new EPR spectrum, (b), is obtained; this can be converted into a third six-line spectrum, (c), by U.V. illumination. The constants of the spectra are for (a) $g = 2.0018 \pm 0.001$, $|A| = (12.0 \pm 0.5) \cdot 10^{-4}$ cm^{-1}; for (b) $g = 2.0020 \pm 0.001$, $|A| = (12.3 \pm 0.5) \cdot 10^{-4}$cm^{-1}, $|D| = (359 \pm 5) \cdot 10^{-4}$ cm^{-1}; for (c) $g = 2.0006 \pm 0.001$, $|A| = (19.8 \pm 0.5) \cdot 10^{-4}$ cm^{-1}. The following models are proposed: (a) $Mn^{++} + e^-$ in substitutional position; (b) $Mn^{++} + 2e^-$ + anionic vacancy; (c) Mn atom in substitutional position. In KCl(Mn^{++}) which has undergone the same treatment the (b) and (c) spectra have been observed, whereas (a) does not appear. (auth)

Radiation Effects

Refer also to abstract 30233.

28858 (AD-640585) STUDY FOR GENERALIZED MODEL FOR SEMICONDUCTOR RADIATION RESPONSE PREDICTION. Quarterly Report No. 5, February 15-June 15, 1966. Raymond, James P.; Johnson, Robert E. (Nortronics, Newbury Park, Calif. Applied Research Dept.). Oct. 1966. Contract DA-28-043-AMC-00423(E). 158p. (ARD-66-49R; ECOM-00423-5). CFSTI $3.00 cy, $0.65 mn.

The detailed bipolar transistor model has been extended to the general large-signal electrical and signal radiation-induced switching responses. Calculations have been made on the delay, rise, storage, and fall times resulting from electrical or radiation-induced common-emitter response. The radiation-induced transient response has been measured over the range of 0.3 to 100 rads (Si) in a nominal 0.2 μsec pulsed radiation environment. Radiation environments were the Nortronics 600-kV Flash x-ray and 10-MeV electron irradiation from the General Atomic LINAC. A brief comparison is made between measured and calculated electrical and radiation-induced responses. The lumped-model analysis has been extended to the circuit elements of junction- and dielectrically isolated integrated circuits. Considered are the resistor, diode, and transistor bipolar elements and the metal-oxide-semiconductor transistor. (auth)

28859 (AD-640804) INVESTIGATION OF TRANSIENT RADIATION DAMAGE IN SEMICONDUCTOR MATERIALS. Quarterly Progress Report No. 3, April 1-June 30, 1966. Corelli, John C.; Frederickson, A. Robb; Westhead, James W. (Rensselaer Polytechnic Inst., Troy, N. Y.). Sept. 1966. Contract DA-28-043-AMC-01788(E). 29p. (ECOM-01788-3). CFSTI $3.00 cy, $0.65 mn.

The transient behavior of the resistivity and Hall effect voltage in 1 to 100 Ω-cm n-type Si and in 100 Ω-cm p-type Si was studied following short bursts (< or = 4.5 microseconds) of 48 MeV electrons. Irradiations were performed with the sample temperatures in the 120 to 300°K range. The excess carrier lifetime was determined by measuring the time decay of resistivity voltage. The single dominant process which occurred was the production of excess carriers from ionization of atomic electrons, and their subsequent decay by recombination. The injection levels induced by the bombarding electrons were high (Delta n/n > 0.1) and in all cases the excess carrier lifetimes exhibited an increase with higher injection level. The number of excess carriers generated can be calculated within a factor of 2 from knowledge of the ionization energy loss, the energy to form an ion pair, and the total integrated electron flux. The temperature dependence of induced conductivity as a function of injection was conducted with that predicted by theory. The transient Hall voltage response of 100 Ω-cm p-type Si can be approximately reproduced by calculation, assuming mixed hole-electron conduction and equal hole and electron decay times, by a single time dependent exponential. A simple model to describe fast annealing in electron-irradiated Si is given. (auth)

28860 (BNWL-356) IRRADIATION PROPERTIES OF HIGH ENERGY RATE PNEUMATICALLY IMPACTED UO_2-PuO_2 FUELS. Bailey, W. J.; Freshley, M. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 40p. Dep. CFSTI.

Irradiation performance of test capsules and PRTR fuel elements containing pneumatically impacted UO_2-PuO_2 fuel material demonstrated that mixed oxides prepared by this process are comparable to or better than ceramic fuels prepared by other processes. The satisfactory performance was demonstrated for linear rod powers to 1276 W/cm (39 kW/ft) and to burnups as high as 5.91×10^{20} fissions/cm^3 (23,800 MWd/tonne). Structures formed during irradiation of pneumatically impacted UO_2-PuO_2 were similar to those formed during the irradiation of UO_2. Homogenization of the mechanically mixed PuO_2-UO_2 occurred at fuel temperatures sufficient to cause in-reactor sintering and grain growth. Good agreement was found between the fission gas release characteristics of capsules and full-sized PRTR elements. Fission gas release values of 90% were obtained for volumetric average fuel rod temperatures of 2200°C. (P.C.H.)

28861 (GEAP-4667) DEVELOPMENT OF UO_2 MICROSTRUCTURES DURING IRRADIATION AT HIGH HEAT RATINGS. Hausner, H.; Nelson, R. C.; Lyons, M. F.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Aug. 12, 1965. Contract AT(04-3)-189. 46p. (EURAEC-1844). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The microstructures of pellet and powder fuels after irradiation at high heat ratings are described. The effect of increasing heat ratings, the influence of the thermal history on the development of the resultant microstructures, and differences in solidification structures are discussed. Calculated values of the thermal con-

ductivity integral for the different microstructural changes are presented. (auth)

28862 (GEAP-5100-4) FISSION PRODUCT AND PLUTONIUM REDISTRIBUTION IN HIGH PERFORMANCE UO_2 FUEL RODS. Davies, J. H.; Boyle, R. F.; Hanus, J. F. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1966. Contract AT(04-3)-189. 68p. (EURAEC-1849). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Radial and axial distributions of ^{137}Cs, ^{144}Ce, and Pu were determined in three UO_2 fuel rods. The rods represented three different levels of fuel thermal performance—incipient center melting, moderate center melting, and gross center melting. Gross radial migration of ^{137}Cs was observed in all three rods and also axial migration in the two higher rated rods. Grain growth was a necessary condition for radial migration, center melting for axial migration. Direct evidence was obtained for convective mixing in the molten UO_2. Burnup in the molten zone was independent of axial location and did not reflect the axial flux profile. Significant segregation of ^{144}Ce and Pu was superimposed on the convective mixing. Such segregation appeared to result from recrystallization of the molten fuel. In addition, separative effects were observed in UO_2, vapor deposited near the top of a central void. In high-rated fuel rods, the deposition of volatile fission products on the inner wall of the cladding might lead to failures from fission product-cladding chemical reactions. However, no tangible link has been established between actual in-pile failures and this phenomenon. U–Pu separative effects in mixed-oxide, fast reactor fuel are important in reactor control. The prompt negative power coefficient provided by fission recoil heating of the ^{238}U depends upon intimate mixing of the ^{238}U and Pu. Separative effects, similar to those observed in high rated UO_2, could reduce this coefficient in mixed-oxide fuel. (auth)

28863 (SORIN-86) RECENT STUDIES ON PYROLYTIC CARBON COATINGS ON FUEL PARTICLES. Walther, H.; Chinaglia, B.; Cocito, G., Domenici, M.; Drago, A. (Societa Richerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). [1966]. 40p. (CONF-660318-3).

From Dragon Contractors' Research and Development Symposium, Harwell, England.

Studies were made on the diffusion of ^{133}Xe in pyrolytic C migration of U in C coatings, and stress induction by heat treatment, anisotropy, and irradiation in pyrolytic C coatings. The diffusion coefficients at 1400°C were in the range $2 \times 10^{-1} \leq D \leq 8 \times 10^{-14}$ cm^2/sec. The low values were attributed to U contamination. U migration was found to be more severe in samples of high porosity after investigations for 300 hr at 1900°C, and during thermal cycling up to 1900°C. After heat treatments of 300 hr at 1900°C, variations in coating structure were found to be more severe when the deposition temperature was lower than the temperature of heat treatment. Stress profiles were calculated as a function of the structural coating anisotropy. A hypothesis is discussed for explaining the phenomena of spear heads and delamination. As a result of the studies, pyrolytic C coatings of high density and high isotropy are being developed. (P.C.H.)

28864 (WAPD-TM-583(Add.1)) A PROCEDURE FOR ANALYSIS OF ZIRCALOY-CLAD BULK OXIDE RODS USING THE CYGRO-1 COMPUTER PROGRAM. Duncombe, E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1967. Contract AT(11-1)-Gen-14. 58p. Dep. CFSTI.

Procedures are specified for using the CYGRO-1 computer program to evaluate the results of irradiation tests of Zircaloy-clad bulk oxide fuel rods and to determine the adequacy of related fuel rod designs. The procedures are discussed in detail and methods are described for handling worst-case conditions for use in fuel rod design, as well as the best estimate of conditions used for evaluation of tests. These procedures were set up as part of the LSBR-LWB development program. (auth)

28865 MICROHARDNESS OF IRRADIATED BERYLLIUM OXIDE. Rau, R. C.; Lacefield, K. (General Electric Co., Cincinnati). Phys. Status Solidi, 21: K69-71(May 1, 1967). (GEMP-466).

Pile ambient irradiation of polycrystalline BeO rods was carried out in ETR at neutron doses from 0.7 to 5.4×10^{20} nvt. Microhardness measurements showed considerable anisotropy. With irradiation, the hardness reached a saturation level at 1.2 to 2×10^{20} nvt, which is the same range in which clustering of point defects occurs. Thus, the hardness changes are related to the formation of point defects. (D.L.C.)

28866 CALCULATION OF THE STORED ENERGY IN IRRADIATED GRAPHITE FROM X-RAY GRAPHIC DATA. Koval'-chenko, M. S.; Ogorodnikov, V. V. At. Energ. (USSR), 22: 138-40(Feb. 1967). (In Russian).

The stored energy in irradiated graphite was calculated from x-ray data taking into consideration the temperature dependence of the coefficient of linear expansion and c. The change of stored energy in the irradiated graphite as a function of the annealing temperature was calculated and compared with experimental data. (J.S.R.)

28867 INFLUENCE OF NUCLEAR IRRADIATION ON PROPERTIES OF REFRACTORY COMPOUNDS. Konozenko, I. D.; Ryzhkov, Yu. T. (Inst. of Physics, Kiev). Fiz.-Khim. Mekh. Mater., 2: 607-15(1966). (In Russian).

Solids exposed to neutron beams undergo apparent changes in their properties. Thermal neutrons can cause nuclear reactions and great disturbance of the crystalline lattice: thermal peaks of displacement arise and dislocations are created. However it was noted that in the irradiation process partial annealing of the radiation defects occurs. The radiation stability of solids depends on their structure and on the type of atomic bonds in the lattice: solids with covalent bonds are less stable than solids with ionic bonds. The thermal stability seems one of the determining characteristics of ceramics. The relative stability of SiC under radiation makes possible its use as a matrix in nuclear fuels. The sensitivity of SiC crystalline lattice to radiation makes possible its use as a monitor for determination of neutron flux. TiC, having a cubic lattice, and MoC carbide with a hexagonal lattice show regularity of the radiation stability of solids: changes in the structure and properties under irradiation appear to a greater degree in them than in solids with an anisotropic crystalline structure. UC and the cermet UC–C appear more stable to radiation than metallic U. The change in the properties of UC at small doses shows the effect of saturation. Pure metallic B and B_4C crack under irradiation. A series of experimental data indicate the absence of cracks in B_4C and the ceramic $B_4C-Al_2O_3$. ZrB_2 shows good stability against radiation. (tr-auth)

Plastics and Other Materials

Refer also to abstracts 28778, 29103, and 29104.

28868 (BMI-X-10194) HEAT-RESISTANT CONCRETE FOR PRESTRESSED-CONCRETE-PRESSURE-VESSEL (PCPV) REACTORS. Quarterly Progress Report, January–March 1967. Fondriest, F. Frederick; Snyder, M. Jack (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1967. Contract W-7405-eng-92. 19p. (EURAEC-1848). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A trial moisture-migration run was made to evaluate the test equipment and procedures. Cylindrical specimens containing two thermocouples and a set of resistivity electrodes were exposed to uniform temperatures of 150, 250, and 500°F to determine the heating and moisture-loss rates. Experiments involving changes in cement composition were begun. Data are presented in tables and graphs. (M.C.G.)

28869 ELECTRON MICROPROBE ANALYSES OF POWDERS DARKENED BY SIMULATED SOLAR-WIND IRRADIATION. Greer, Raymond T. (Pennsylvania State Univ., University Park); Hapke, Bruce W. J. Geophys. Res., 72: 3131-3(June 15, 1967).

Fused quartz, natural quartz, and alumina in powdered form were darkened by irradiation by H_2 and He ions of solar-wind energies and subsequently examined with an electron microprobe. Fe, W, and C were detected on the samples. It is not possible at this time, however, to state whether or not these contaminants were responsible for the observed darkening. (auth)

28870 PULSE RADIOLYSIS STUDIES OF AQUEOUS PHENOL. WATER ELIMINATION FROM DIHYDROXYCYCLOHEXADIENYL RADICALS TO FORM PHENOXYL. Land, E. J.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Trans. Faraday Soc., 63: 1181-90(May 1967).

The reactions of e^-_{aq}, H· and OH· with phenol were studied. The corresponding rate constants were 1.8×10^7, 1.8×10^9, and 1.4×10^{10} M^{-1} sec^{-1}, respectively. The product detected after e^-_{aq} and H· attack was the H adduct ($\epsilon_{3300Å} = 3800$ M^{-1} cm^{-1}). The initial product of OH· attack was the OH adduct ($\epsilon_{3300Å} = 4400$ M^{-1} cm^{-1}). Both H and OH adducts are probably mixtures of isomers. OH adducts subsequently undergo either unimolecular elimination of water to form the more resonance-stabilized phenoxyl radical, $\phi O\cdot$ ($\epsilon_{4000Å} = 2200$ M^{-1} cm^{-1}), or bimolecular radical–radical reactions. The elimination is catalyzed by H^+, OH^- and HPO_4^{2-} ions. There are indications of different rates of catalysis for different isomers of the OH adduct. The uncatalyzed rate of elimination is $<10^3$ sec^{-1}. The elimination was also detected from OH adducts of p-cresol (to

give p-$CH_3C_6H_4O^{\bullet}$, $\epsilon_{400m\mu} = 2400\ M^{-1}\ cm^{-1}$) and tyrosine. The ability to eliminate water appears to be a general property of OH adducts of phenols. (auth)

28871 THE EFFECT OF NEUTRON IRRADIATION ON SOME MECHANICAL PROPERTIES OF DIAMOND. PART 2. THE POLISHING OF DIAMOND. Wilks, Eileen M. (Oxford Univ.). Ind. Diamond Rev., 27: 154-9(Apr. 1967).

The effects of neutron irradiation on the abrasion hardness, cleaving, and polishing of diamond was studied. (auth)

28872 RADIATION INVESTIGATIONS OF A NEW ORGANIC COOLANT FOR REACTOR TECHNOLOGY. Benning, A. (Bergbau-Forschung GmbH, Essen); Glass, W.; Hattenbach, K.; Melkonian, G. A.; vom Baur, E. Atomkernenergie, 12: 123-9 (Mar.-Apr. 1967). (In German).

Hydrocarbons with aromatic rings linked by methylene bridges can undergo condensation as well as decomposition reactions under influence of radiation, so that molecular and specific weight, viscosity a.s.o. will be less altered than in the case of polyphenyls. Irradiation experiments were performed with dibenzyltoluene (DBT) using the beamhole-loop of FRG at 300° — without filter — and at 350°C with adsorption filter. The radiation stability of DBT corresponds with diphenyl. At 350°C and with adsorption filter (attapulgus clay) a kind of equilibrium state is achieved by means of producing low molecular benzene homologs (decomposition), derivates of anthracene (ring closure), and polymers, thus stabilizing physical properties. The substance — remaining liquid up to a high content of distillation residue — seems being applicable as coolant in reactor technique instead of polyphenyls. (auth)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 28092, 28967, 28972, 29030, 29107, 29132, 29257, 29307, 29396, 29409, and 29559.

28873 (TID-23827, pp 15-26) RADIO ASTRONOMY. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Brief summaries of research carried out during this period are reported on: interpretation of spectral data, microwave dielectric constant and emissivity of a solution approximating seawater, hydrogen recombination line observations, and observations of OH emission. (M.O.W.)

28874 EINSTEIN A COEFFICIENTS FOR THE 18 cm TRANSITIONS OF OH. Carrington, A.; Miller, T. A. (Cambridge Univ., Eng.). Nature, 214: 998-8(June 3, 1967).

A number of recent papers have dealt with values of the Einstein A coefficients describing spontaneous emission for the hyperfine split $^2\Lambda_{\frac{1}{2}}$, $J = \frac{3}{2}$, Λ-doublet transition in OH. These values are important in connection with determinations of the interstellar abundances of OH and the non-Boltzmann population of the hyperfine levels. At least four different sets of calculated values have been presented. The methods employed have involved complicated algebraic manipulation, and an incorrect matrix element. The present authors approached the problem in a different way, using Racah algebra and the transformation theory of the group of all rotations in free space. This method gives a check on previous calculations, and also provides a general formula for the squared matrix elements in the A coefficient which is applicable for any multipole transition within or between J levels in a Hund's case (a) molecule containing a single magnetic nucleus of spin I. The more general approach presented is, in some ways, easier than the previous calculations in that the sum rules and orthogonality relations of the general theory allow the application of calculation checks at various stages. Results are discussed, and compared with those of other workers. (UK)

28875 SPALLATION AND FISSIOGENIC XENON AND KRYPTON FROM STEPWISE HEATING OF THE PASAMONTE ACHONDRITE; THE CASE FOR EXTINCT ^{244}Pu IN METEORITES; RELATIVE AGES OF CHONDRITES AND ACHONDRITES. Hohenberg, C. M.; Munk, M. N.; Reynolds, J. H. (Univ. of California, Berkeley). J. Geophys. Res., 72: 3139-77(June 15, 1967). (UCB-34P32-51).

Following the discovery by Rowe and Kuroda that there are striking excesses of the xenon ratios 134/132 and 136/132 in the Pasamonte achondrite, stepwise heating experiments were performed with this meteorite. Xenon results from three experimental systems were concordant. The ratio 124/130 is linearly correlated with the ratio 126/130, showing a (cosmogenic) spallation component. Ratios reported by other laboratories for total xenon from various achondrites and a mesosiderite fall on this correlation line. The ratio 134/132 is linearly correlated with the ratio 136/132, showing a component presumed to be from fission. The line so defined is a gross but accurate extrapolation of the "Pepin line," which is now seen to be applicable to both chondrites and achondrites. The Pasamonte data of this study, taken alone, permit calculation of the isotopic composition of the fission and spallation components which are: fission, 131/132/134/136 = 0.285/1.00/1.06/1.13; spallation, 124/126/130/131/132 (assumed zero) = 0.285/0.995/1.00/4.48/0. The Pasamonte data of this study combined with Berne data for the highly cosmogenic Stannern achondrite provide an alternative but similar set of values: fission, 131/132/134/136 = 0.31/1.00/0.98/1.02; spallation, 124/126/128/130/131/132 = 0.58/1.00/1.34/0.73/2.76/0.08. Krypton data from the stepwise heating experiment provide ratios 80/84, 82/84, and 83/84 that are linearly correlated, showing a spallation component. Results from other laboratories for total krypton from achondrites and a mesosiderite fall on the correlation line. A preferred composition of the spallation krypton results from Berne measurements on Stannern and the current measurements on Pasamonte: 80/82/83/84 = 0.52/0.75/1.00/0.42. The ratio 86/84 does not correlate with the others, suggesting detectable fission krypton in Pasamonte, but background interference makes this a weak conclusion at present. Results for the amounts and compositions of the spallation components agree generally well with calculations based on a formula due to Rudstam and a cosmic-ray spectrum given by Arnold and co-workers. The case for 82-m.y. ^{244}Pu as an extinct radioactivity in meteorites rests on the following evidence: (1) the fission component in xenon differs isotopically from any possible fission component from uranium; (2) the concentration of fission xenon exceeds that attributable to uranium in Pasamonte by at least a factor of 15; (3) arguments are given that rule out other sources of the fission component such as primitive irradiations by slow neutrons, fast neutrons, or γ rays. Previous experiments on ordinary and carbonaceous chondrites can be reexamined in light of the ^{244}Pu hypothesis. At face value, the fission components for chondrites are very large, suggesting that ordinary chondrites cooled at least 168 m.y. earlier than achondrites, and carbonaceous chondrites cooled at least 416 m.y. earlier than achondrites. An initial Pu/U ratio in carbonaceous chondrites would have to exceed 0.26, a result that would require that there was extensive local nucleosynthesis of the transbismuth elements shortly before the origin of the solar system, conflicting with present theories about the evolution of uranium in the solar system. An experiment is proposed to test possible correlation of the fission component at retentive sites in the meteorite with fission xenon produced at uranium sites by pile neutrons. (auth)

28876 ORIGIN OF METEORITES. Yokoyama, Yuji; Mabuchi, Hisao (CNRS, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 494-5(Feb. 6, 1967). (In French).

A study of the different neutron fluxes creating, on one side short-lived nuclides and on the other side long-lived nuclides for a certain number of chondrites leads to the assumption that the chondrites come from the border region of the solar system and that the minor axis of the orbit of the chondrites is greater than 13 a.u., which would indicate the cometary origin of the meteorites. (tr-auth)

28877 FLUCTUATING POLARIZATION IN LONG-PERIOD VARIABLE STARS. Zappala, R. R. (Univ. of Chicago). Astrophys. J., 148: L81-5(May 1967).

A set of fourteen high-galactic-latitude semiregular and Mira variables was observed polarimetrically. Well-defined variations in the amount and/or direction of polarization were found in seven of the stars while an additional four had polarizations large enough to make an intrinsic origin a likely possibility. No simple correlation between light and polarization curves was revealed. The irregularly variable supergiant μ Cep was also observed to undergo substantial polarization changes. (auth)

28878 MICROTURBULENCE VERSUS METAL ABUNDANCE: AN OBSERVATIONAL TEST. Barry, Don C. (Univ. of Arizona, Tucson). Astrophys. J., 148: L87-9(May 1967).

A statistical analysis of uvby and Hβ photometric data for late-F dwarfs was made in order to determine quantities directly comparable to Conti and Deutsch's corrected numerical values for the sensitivities of the Strömgren indices m_1 and b−y to changes in abundance and microturbulence. The analysis indicated, however, that the observed variation in the m_1 index is due primarily to variations in abundance—not to differences in microturbulence. Furthermore, it showed that the β index is less affected by abundance blanketing than the b−y index and is, therefore, a more accurate indicator of effective temperature. (W.D.M.)

28879 ANGULAR DIAMETER OF 3C 279 FROM INTERPLANETARY SCINTILLATIONS. Cohen, M. H.; Gundermann, E. J. (Univ. of California, San Diego. Cornell Univ., Ithaca, N. Y.). Astrophys. J., 148: L49-51(May 1967).

In earlier papers on interplanetary scintillations, it was shown how the width of the fluctuation spectrum can give a limit to the angular diameter of a scintillating source. An interpretation is given for the source 3C 279, which displays the widest fluctuation spectrum seen to date, and for which, consequently, one can give the lowest upper limit to the angular diameter. The observations were made with the 140-foot telescope at the NRAO on Sept. 30–Oct. 11, 1966. (W.D.M.)

28880 OPTICAL POLARIZATION MEASURES OF FIVE RADIO SOURCES. Kinman, T. D. (Univ. of California, Santa Cruz). Astrophys. J., 148: L53-6(May 1967).

The discovery of time-dependent linear polarization in the optical radiation of 3C 446 during a recent outburst has prompted a search for optical polarization in other radio sources. The percentage polarization and the position angle in equatorial coordinates of the plane of polarization are given for 3C 279, 3C 345, 0405-12, 0430 + 05, 0837-12, and BD + 8° − 1314. (W.D.M.)

28881 RED SHIFTS OF TEN RADIO GALAXIES. Wills, D. (Univ. of Texas, Austin). Astrophys. J., 148: L57-8(May 1967).

The red shifts of ten radio galaxies were measured from spectra obtained at McDonald Observatory. The galaxies are from Caswell and Wills' list of identifications of 4C radio sources

with bright galaxies. The spectra were obtained with an Astro Mechanics Meinel grating spectrograph having a 3-in. collimated beam, and an S-20′ image tube, at the Cassegrain focus of either the 36-inch or 82-inch reflector. The spectral range covered was approximately 5000 to 7250 Å. (W.D.M.)

28882 SPECTROSCOPIC OBSERVATIONS OF NINETEEN QUASI-STELLAR RADIO SOURCES. Kinman, T. D.; Burbidge, E. M. (Univ. of California, Santa Cruz. Univ. of California, San Diego). Contract NsG-357. Astrophys. J., 148: L59-63 (May 1967).

Red shifts were determined for nineteen quasars, thirteen of which had not been previously determined. The spectrograms were obtained at the prime focus of the 120-inch reflector using both the conventional spectrograph and the new spectrograph that incorporates an RCA image tube. The wavelengths of the emission lines which were measured are given, together with an indication of the strengths and widths of the lines. The red shifts and the computed rest wavelengths of the lines are given. (W.D.M.)

28883 PREDICTED EMISSION SPECTRA OF QUASI-STELLAR SOURCES IN THE FAR ULTRAVIOLET. Bahcall, John N.; Sargent, Wallace L. W. (California Inst. of Tech., Pasadena. Carnegie Inst. of Washington, D. C.). Astrophys. J., 148: L65-8(May 1967).

The main emission features of quasi-stellar sources at wavelengths shorter than Lyman-α (λ = 1215 Å) is predicted. The main emission lines which might be found in objects having emission redshifts Z > 2 and which might, therefore, aid in the discovery of such large red shift objects are singled out. Some observational consequences that obtain for quasi-stellar sources that are optically thick beyond the Lyman limit are pointed out. (W.D.M.)

28884 OBSERVATIONS OF OH EMISSION IN THE H_{II} REGION W3 WITH A 74400 λ INTERFEROMETER. Moran, J. M. (Massachusetts Inst. of Tech., Cambridge); Barrett, A. H.; Rogers, A. E. E.; Burke, B. F.; Zuckerman, B.; Penfield, H.; Meeks, M. L. Contract DA-28-043-AMC-02536(E). Astrophys. J., 148: L69-72(May 1967).

Observations were made of the 1665 MHz transition in the source W3 during Nov. 1966 and Jan. 1967. Increased angular resolution was obtained with a new interferometer, by using the 84-foot Millstone antenna and the 60-ft antenna at the Agassiz Field Station. The baseline was 74400 λ at 18 cm along a bearing of 24° east of north, which gives a minimum fringe spacing of approximately 3″. An effective system temperature of 300°K was achieved. The strongest spectral feature of W3 yielded a signal-to-noise ratio of 8:1, with only 1 min. of integration. (W.D.M.)

28885 THE ORIGIN OF QUASISTATIONARY GAS FLOW FROM SOLAR ACTIVE REGIONS. I. Mustel, E. R. (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 899-908(May-June 1967).

Translated from Astron. Zh., 43: 1121-34(Nov.-Dec. 1966).

Evidence is presented that quasi-stationary corpuscular streams emanating from active regions on the Sun in their magneto-optical phase are responsible for most recurrent geomagnetic disturbances. Additional objections are raised against the "cone of avoidance" hypothesis: The solar plasma would have to contain a large velocity component perpendicular to the radial direction, but no such component is observed. The disturbance lag time Δt_0 is investigated as a function of solar-cycle phase; the phase dependence is considerably weaker than found previously. The principal M-disturbance sequences from 1921 to 1964 are described in detail and the following inferences are drawn: (a) The intensity of individual disturbances in a geomagnetic sequence correlates poorly with optical-activity variations inside active regions (this result applies to practically all sequences). (b) Some or even many M-sequence members, frequently with strong geomagnetic activity, often exhibit very weak or negligible optical activity in the corresponding solar regions. (c) In all cases considered the initial M-sequence members can be identified naturally with an active region in the magneto-optical phase; subsequently the sequence is generated by the same active region in its magnetic phase. (d) M sequences are not associated with filaments. (e) In many cases, but not always, M-disturbances exhibit no appreciable seasonal fluctuations corresponding to B_0 variations. (f) On the average M sequences follow a 27-day calendar, although in some cases the disturbance commencement is displaced relative to this calendar, with the lag time Δt_0 decreasing from 4 to 5 to 2 to 3 days. (auth)

28886 RADIO EMISSION AND ATMOSPHERIC STRUCTURE ABOVE SUNSPOTS. Livshits, M. A.; Obridko, V. N.; Pikel'ner, S. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow. Shternberg Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 909-14(May-June 1967).

Translated from Astron. Zh., 43: 1135-42(Nov.-Dec. 1966).

The circularly polarized magnetobremsstrahlung at centimeter wavelengths from regions above sunspots requires a field H ≈ 1000 Oe and a coronal temperature ≈ 10^6 °K. Direct observations of photospheric and chromospheric fields and theoretical indications for strong broadening of the magnetic tube of force in rarefied atmospheric layers imply that H ≈ 1000 Oe only below 3000-km height. Thus the corona evidently begins at a small height above spots. A model radio source is computed from observed radio spectra and information on circular polarization. A hydrostatic density distribution is assumed. The radio data furnish a fairly reliable T(h) curve. A natural explanation is also obtained for the directivity of the radiation, the sharp source boundary, and the correspondence between sources and spot umbrae. The chromosphere above spots differs from the ordinary chromosphere because of the poor dissipation of Alfvên and accelerated waves in a strong field. Retarded (sound) waves decay low in the chromosphere, generating no appreciable heating. Apparently only accelerated waves can penetrate the corona, where they are transformed into other types of wave and decay at a great height. Energy is thence transported by heat conduction into the low coronal layers responsible for the radio emission. (auth)

28887 TEMPERATURE OF A CORONAL CONDENSATION. Nikol'skii, G. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 915-18(May-June 1967).

Translated from Astron. Zh., 43: 1143-7(Nov.-Dec. 1966).

The existence of regions of varied temperature in the corona is discussed. An analysis is made of data on Lyot and Aly's spectrum of the February 25, 1952 condensation. The emission measure $EM(T_1)$ for the region where a particular ion radiates as a function of ionization temperature is shown. The condensation and the corona contain three types of region, differing in temperature (0.8, 1.5, and $2.8 \cdot 10^6$ °K), each measuring ≈10^9 cm. The 6304.6-A line observed by Wlérick and Fehrenback is identified with Co XII $^3P_1 - {}^3P_2$ radiation. (auth)

28888 GENERATION MECHANISM FOR DRIFTING DECIMETER BURSTS OF SOLAR RADIO WAVES. Zaitsev, V. V. (Gorky State Univ., USSR). Soviet Astron. AJ (Engl. Transl.), 10: 919-26(May-June 1967).

Translated from Astron. Zh., 43: 1148-58(Nov.-Dec. 1966).

A plasma mechanism for generating drifting decimeter bursts is described. The bursts can be interpreted as radio emission by strong (M > 6) shock waves in the solar chromosphere. This radiation is produced through excitation of ion sound in a hot electron zone ahead of the shock front, with subsequent transformation into high-frequency ($\omega \approx \omega_L$) electromagnetic waves through scattering by thermal plasma fluctuations. Several properties of the radiation are predicted: its intensity, frequency-spectrum width, and directivity. The area occupied by burst sources on the solar disk and the burst lifetime are estimated. (auth)

28889 NEW SPECTROSCOPIC ORBIT OF YZ CASSIOPEIAE. Perry, Charles L. (Kitt Peak National Observatory, Tucson, Ariz.); Stone, Sidney N. Publ. Astron. Soc. Pac., 78: No. 460, 5-13(Feb. 1966). (LA-DC-7721).

Recently, Struve has stressed the need for periodic determinations of the velocity curves of all the brighter spectroscopic binaries. To this end, 92 plates of YZ Cassiopeiae suitable for measurement were obtained between June 1954 and Feb. 1956, using the Mills spectrograph attached to the 36-inch refractor of the Lick Observatory. The spectra, all assigned unit weight, were recorded on Kodak IIa-O emulsion at a dispersion of 11 Å/mm at λ 4500. (W.D.M.)

28890 ATOMIC FLUORESCENCE AND EMISSION LINES FOR LONG-PERIOD VARIABLE STARS. Gauzit, J. (Observatoire de Lyon, Saint-Genis-Laval, France). Ann. Astrophys., 30: 55-7 (Jan.-Feb. 1967). (In French).

An explanation is proposed for the selective excitation of the Fe(I) $z^5 G^0_2$ levels in M stars and Cr(I) $z^5 F^0_1$ levels in S stars, and it is shown that fluorescence can explain the origin of several previously unidentified emission lines of long-period variables. In particular, the 3742.30 line observed in R And was assigned to Nb(I). The conditions for excitation by atomic fluorescence are particularly favorable in the atmospheres of long-period variable stars. However, this fluorescence does not appear to be capable of explaining the origin of the more intense 3735.31 emission line which has not been identified. According to wavelength tables, it is possible to admit tentatively the implication of the 3735.325 line of Fe(I), multiplet 388 ($Z^7P^0_4 - e^7P_4$), but this identification is not acceptable because the other lines of the same multiplet or those which have the same level are absent in the spectra of these stars. (BBB)

28891 PHOTOELECTRIC OBSERVATIONS OF 3C 446. Wampler, E. Joseph (Univ. of California, Santa Cruz). Contract NSR-05-003-100. Astrophys. J., 148: L101-6(May 1967).

Results are given of observations obtained in the interval August 17 to December 12, 1966 on the changes in the spectral energy distribution of 3C 446. The data were obtained using the Lick Observatory prime-focus scanner attached to the 120-inch telescope. Blue observations were obtained with a 60 Å exit slot; a 120 Å exit slot was used in the red. (W.D.M.)

28892 LIMITS TO THE DISTANCES OF THE QUASI-STELLAR OBJECTS DEDUCED FROM THEIR ABSORPTION LINE SPECTRA. Burbidge, G. R.; Burbidge, E. M. (Univ. of California, San Diego). Contract NsG-357. Astrophys. J., 148: L107-13(May 1967).

The absorption- and emission-line red shifts are given for all quasars with several absorption lines. It is shown that for all of the objects the absorption-line red shift is very close to 1.95. The significance of this value is discussed in detail, and the question as to whether this could be due either to night-sky features or to interstellar absorption is considered. Arguments are presented and it is concluded that the quasars cannot lie at cosmological distances but they must be comparatively "local" (40 Mpc) objects. (W.D.M.)

28893 SAGITTARIUS A AS A POSSIBLE COSMIC-RAY INJECTOR. Kuril'chik, V. N. (Shternberg Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 1055-6(May-June 1967).

Translated from Astron. Zh., 43: 1317-18(Nov.-Dec. 1966).

The synchrotron nature and lack of peculiarities in the radio spectrum of the central component of the Sgr A source indicate a continuous rather than an eruptive process for the acceleration and escape of relativistic particles from the galactic center. A lower bound is estimated for the escape rate of relativistic particles from this object. (auth)

28894 ON THE NATURE OF A NEW FEATURE IN THE GALAXY M 81. Vorontsov-Vel'yaminov, B. A. (Shternberg Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 1057-8(May-June 1967).

Translated from Astron. Zh., 43: 1318-19(Nov.-Dec. 1966).

The feature in M 81 discovered by Arp that has the shape of a faint loop is interpreted as a stellar configuration similar to various appendages observed in many galaxies, and unrelated to explosive phenomena in neighboring systems. (auth)

28895 POLARIZATION OBSERVATIONS OF DQ HERCULIS (NOVA HERCULIS 1934). Dibai, E. A.; Shakhovskoi, N. M. (Shternberg Astronomical Inst., Moscow. Crimean Astrophysical Observatory, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 1059-60(May-June 1967).

Translated from Astron. Zh., 43: 1319-21(Nov.-Dec. 1966).

Polarization observations of DQ Her indicate substantial variations in the polarization parameters during minimum light (eclipse). These variations yield a position for the orbit plane of the close binary system very similar to the direction of the major axis of the envelope observed after the 1934 nova outburst. (auth)

28896 CHARACTER OF MOTIONS AND EMISSION-LINE ASYMMETRY IN CHROMOSPHERIC FLARES. Guseinov, R. E. (Shemakha Astrophysical Observatory, Baku). Soviet Astron. AJ (Engl. Transl.), 10: 927-33(May-June 1967).

Translated from Astron. Zh., 43: 1159-67(Nov.-Dec. 1966).

The line-broadening mechanism for the June 25, 1960 flare is the Doppler effect induced by macroscopic motion inside the emission region. This is the only broadening mechanism for the Balmer lines up to Hε. Higher Balmer terms are broadened by combined Stark and Doppler effects; the Doppler contribution increases with turbulent velocity. The macroscopic turbulent velocity is greatest for hydrogen and least for metals, with Ca^+ in intermediate position, suggesting different emission regions. Ellison's hypothesis that the asymmetry in flare line profiles may arise through absorption of flare radiation by clouds moving above the flare should be rejected. Instead, the asymmetry may result from a flow of comparatively small condensations in the flare region with a mean velocity directed either toward or away from the solar surface. Superposed on the appropriate wing, the added radiation from these condensations produces the asymmetry Their velocity would follow a Maxwellian distribution. A velocity gradient is found at certain phases of flare development. The asymmetry increases with the "relative" velocity of the stream of condensations. (auth)

28897 PHOTOELECTRIC AND SPECTROGRAPHIC OBSERVATIONS OF FLARES IN AD LEONIS DURING 1965. Gershberg, R. E.; Chugainov, P. F. (Crimean Astrophysical Observatory, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 934-43(May-June 1967).

Translated from Astron. Zh., 43: 1168-78(Nov.-Dec. 1966).

The method and provisional results of concurrent photoelectric and spectrographic observations of the flare star AD Leo are described. These were obtained with the 64-cm meniscus telescope and the 2.6-m Shain reflector equipped with a grating spectrograph and an electronic image converter. Spectra were taken in the red, green, and blue regions with a time resolution from 4 to 60 sec. In 27.5 h of observation, five flares were recorded photoelectrically, with spectra for four of them. Light curves are shown for each flare and the estimated luminosity is given. All the spectrograms are described in detail. For various phases of flare development and for the quiescent state of AD Leo the following quantitative spectral parameters were measured: intensity, width, and equivalent width of the hydrogen, helium, and calcium emission lines; intensity jump at the TiO bandheads; and central residual intensity of the λ 4226 Ca I line. (auth)

28898 DYNAMICS OF THE RISE OF A SUNSPOT MAGNETIC FIELD INTO THE CORONA AND SOME RESONANCE PROPERTIES OF CORONAL ACTIVE REGIONS. Merkulenko, V. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 944-8(May-June 1967).

Translated from Astron. Zh., 43: 1179-85(Nov.-Dec. 1966).

If a loop prominence contains a certain field configuration, it can expand by stretching in some direction with no change in the magnetic field energy. The possibility that standing Alfvén waves might develop in such a prominence is discussed. (auth)

28899 VISCOSITY EFFECTS IN AN EXPANDING SOLAR CORONA. Ponomarenko, Yu. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 949-54(May-June 1967).

Translated from Astron. Zh., 43: 1186-93(Nov.-Dec. 1966).

Viscous effects are considered in a spherically symmetric, expanding model solar corona, heated by thermal conductivity only. As the viscosity increases the solutions describing the state of the corona become smoother. Asymptotic solutions are found for the equations of coronal gas motion. The conditions for hydrodynamic description of the corona at large distances are investigated. (auth)

28900 TEMPERATURE GRADIENT IN THE ATMOSPHERES OF MAGNETIC AND PECULIAR STARS. Glagolevskii, Yu. V. (Astrophysical Inst., Alma-Ata, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 955-8(May-June 1967).

Translated from Astron. Zh., 43: 1194-9(Nov.-Dec. 1966).

An attempt is made to explain the anomalous energy distribution in the continua of various magnetic and peculiar stars by assuming a reduced temperature gradient in the atmosphere. This assumption is supported by computations of the energy distribution performed for reduced temperature gradients. (auth)

28901 ADIABATIC OUTFLOW FROM A STAR AND EQUILIBRIUM STATES WITH EXCESS ENERGY. Bisnovatyi-Kogan, G. S.; Zel'dovich, Ya. B. Soviet Astron. AJ (Engl. Transl.), 10: 959-63(May-June 1967).

Translated from Astron. Zh., 43: 1200-6(Nov.-Dec. 1966).

An exact solution is obtained for the state in which an adiabatic star has a nearly stationary core and an envelope shedding mass. A special equation of state is adopted. The fitting conditions for the core and envelope solutions are established; the results, including the mass-loss rate, are independent of the fitting point of the solutions. In the state considered the star has positive energy, but an energy barrier prevents its rapid dispersal to infinity. Exact equilibrium states with positive energy, stable against all small perturbations, can exist within Newtonian gravitation theory. (auth)

28902 SPECTROPHOTOMETRY OF THE RADIO SOURCE CTA 102. Pronik, V. I. (Crimean Astrophysical Observatory, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 964-6(May-June 1967).

Translated from Astron. Zh., 43: 1207-10(Nov.-Dec. 1966).

The equivalent widths of the [C III] 1909 A and [Mg II] 2798 A emission lines in CTA 102 were determined. The spectral index $\alpha \approx 1$ for the observed region. The radiating gas has a mass $M \gtrsim 10^6 M_\odot$ and covers a region of diameter $r \lesssim 30$ pc. (auth)

28903 VARIABILITY OF THE OPTICAL SPECTRUM OF 3C 345. Shklovskii, I. S. (Shternberg Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 967-9(May-June 1967).

Translated from Astron. Zh., 43: 1211-14(Nov.-Dec. 1966).

An estimate is obtained for the linear size of the clouds exhibiting variable Mg II emission near the nucleus of 3C 345. The variability could arise from a "clearing" of these clouds in the resonance-line frequencies because of strong heating and ionization by powerful relativistic-particle streams. The intensity of the process of mass ejection from the quasar nucleus and an upper bound on the nucleus mass are estimated. Prolonged systematic observations of the variable Mg II line profile in the 3C 345 spectrum would be desirable. Variability in the Mg II lines might be quite common in quasar spectra. (auth)

28904 KINETIC EQUILIBRIUM OF β-PROCESSES IN STELLAR INTERIORS. Imshennik, V. S.; Nadezhin, D. K.; Pinaev, V. S. Soviet Astron. AJ (Engl. Transl.), 10: 970-8(May-June 1967).
Translated from Astron. Zh., 43: 1215-25(Nov.-Dec. 1966).

The kinetic equilibrium at high temperatures of β processes involving electron–positron pairs is discussed. A detailed study is made of the free-nucleon case. The equilibrium concentrations derived for free protons and neutrons are not greatly different from values computed for complete thermodynamic equilibrium and a neutrino chemical potential of zero. The characteristic relaxation time t_τ is derived for β processes near equilibrium; for $T_9 \cong 16$, $t_\tau < 0.3$ sec. (auth)

28905 A HERTZSPRUNG–RUSSELL DIAGRAM BASED ON STELLAR EVOLUTION THEORY. Dluzhnevskaya, O. B. (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 979-85(May-June 1967).
Translated from Astron. Zh., 43: 1226-33(Nov.-Dec. 1966).

Evolutionary sequences of model stars with masses of 3 to 30 $M_\odot$ are used to construct a theoretical H–R diagram for groups of stars of age 10^7 to $2 \cdot 10^8$ yr. The Salpeter–Sandage ψ function is adopted for the star distribution on the zero-age main sequence. The theoretical diagram is compared with observed H–R diagrams for 11 open clusters in the Galaxy and two in the Small Magellanic Cloud, with color functions for Ia-Ib supergiants in the solar neighborhood, and with color-luminosity functions for stars in the Large Magellanic Cloud and M 31. For high-luminosity stars ($M_v < -6^m$) the theoretical estimates agree with observed counts, but at lower luminosities ($-6^m < M_v < 0^m$) the predicted number of stars in the Hertzsprung-gap region systematically exceeds the observed number. This effect casts doubt on the looped behavior predicted for model-star evolutionary tracks in the gap, and suggests there may be some difficulties with current theory for the late evolutionary stages of massive stars. (auth)

28906 A POSSIBILITY FOR DETERMINING THE TANGENTIAL VELOCITIES OF REMOTE STARS, NEBULAE, AND GALAXIES. Baranov, A. G. Soviet Astron. AJ (Engl. Transl.), 10: 986-8(May-June 1967).
Translated from Astron. Zh., 43: 1234-6(Nov.-Dec. 1966).

A method based on the transverse Doppler effect is proposed for determining the tangential velocities of stars. (auth)

28907 SOURCES OF ^{3}He AND POSSIBILITIES FOR OBSERVING IT. Syunyaev, R. A. Soviet Astron. AJ (Engl. Transl.), 10: 989-94(May-June 1967).
Translated from Astron. Zh., 43: 1237-43(Nov.-Dec. 1966).

Some possible sources of ^{3}He in cosmic objects are described. Estimates are obtained for the ^{3}He and deuterium abundance in the interstellar medium, supernova remnants, and the intergalactic gas. The 3.5-cm radio line of the ^{3}He II ion might be observable in several objects. The line intensity is estimated for the central Orion Nebula (flux $F \approx 4.5 \cdot 10^{-25}$ W/m^2 · cps, $\Delta\nu \approx 300$ kc), the Crab Nebula, the galaxy M 82, the galactic-center direction, and other sources. (auth)

28908 IRRADIATION AGE AND ORIGIN OF IRON METEORITES. Voshage, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 22a: 477-506(Apr. 1967). (In German).

Cosmic-ray exposure ages of more than 60 iron meteorites were determined using the ^{41}K/^{40}K method. Isotope fractionation processes and the reproducibility of age values were studied. Correlations were found between exposure ages and structural classes as well as Ga–Ge groups. These prove that the groupings of iron meteorites according to some of their structural and compositional features are due to the fact that only a few distinct parent iron masses essentially contributed to the production of iron meteorites. Some of these parent masses supplied the meteorites mainly in one or two "catastrophic" collisions and breakup events, others in a quasi-continuous series of events over a period of many hundreds of million years. Medium and fine octahedrites of the Ga–Ge group III were, essentially produced in two major collisions 600 and 700×10^6 yr ago and fine octahedrites of the Ga–Ge group IVa in one collision about 400×10^6 yr ago. These events supplied about 50% of all iron meteorites. Hexahedrites, coarse octahedrites of the Ga–Ge group I and nickel-rich ataxites revealed age distributions that appeared rather continuous. Mean interplanetary lifetimes deduced from these distributions were about 100×10^6 yr for hexahedrites (according to Waenke), 500×10^6 yr for nickel-rich ataxites, and 700×10^6 yr for coarse octahedrites of the Ga–Ge group I. The differences in the statistics of meteorite production events for different meteorite classes indicated that fundamental dissimilarities may exist in the parent iron masses and parent celestial bodies. The hexahedrites, coarse octahedrites, and ataxites are fragments of a multiplicity of nickel–iron inclusions within the surface layers of the moon, Mars, and asteroids, respectively. These fragments, together with stone meteorites, were produced in a multiplicity of crater-forming impacts by comets on the moon, Mars, or asteroids. Rather compact and large nickel–iron masses, perhaps fragments of asteroidal nickel–iron cores are considered parent masses of the fine octahedrites and medium octahedrites of the Ga–Ge groups III and IVa. The meteorites of each group were produced either when such a nickel–iron mass hit another asteroid or when a comet hit the nickel–iron mass. Surface material is expected to survive the catastrophe in form of structurally undisturbed meteorites, of which a considerable portion may have been exposed to cosmic rays to a measurable degree prior to the collision. Possible conclusions from a comparison of ^{41}K/^{40}K age values with ^{36}Ar/^{36}Cl and similar ages are reconsidered. (auth)

28909 EXISTENCE OF RADIO STARS? Wlerick, G.; Veron, P. (Observatoire de Paris). Ann. Astrophys., 30: 341-5(Mar.-Apr. 1967). (In French).

A star has been found in the neighborhood of seven radiosources of the revised 3C catalog with high galactic latitude and with positions known with a good or medium accuracy. To check if these coincidences are due to chance, a search was made for stars in the neighborhood of sources identified with quasars. The only two observed coincidences correspond to two quasars with galactic latitude lower than 10°. The possibility is suggested that these seven radiosources are physically associated to the stars and form a new class of radiosources, the radiostars. (auth)

28910 CONTRIBUTION TO THE STUDY OF THE STRUCTURE OF MAGNETIC FIELDS IN SUNSPOTS. Rayrole, Jean (Observatoire de Paris). Ann. Astrophys., 30: 257-300(Mar.-Apr. 1967). (In French).

A method is described for complete observation of magnetic field structure in sunspots. The field is determined by its intensity H, the angle ψ with the line of sight, and the azimuth Φ of the transversal component. The photographic method used has many advantages. (W.D.M.)

28911 RESEARCH ON THE HOMOGENEITY OF SOLAR PROMINENCES WITH THE AID OF PHOTOGRAPHS IN MONOCHROMATIC LIGHT. Leroy, Jean-Louis (Observatoire du Pic du Midi, Bigorre, France). Ann. Astrophys., 30: 249-56(Mar.-Apr. 1967). (In French).

Photographs were obtained of solar prominences through different monochromatic filters which enable one to study separately characteristic emissions from hydrogen (Hα and Hβ), helium (D3), and sodium (D2). No important difference between prominence images obtained from these various radiations was found. (auth)

28912 STUDY OF THE STAR χ DRACONIS. Spite, Monique (Observatoire de Paris). Ann. Astrophys., 30: 211-47(Mar.–Apr. 1967). (In French).

Using a series of high-dispersion spectra (3 and 4 Å/mm) the double star χ Draconis, which is apparently of the same age as the sun, was studied. Measurements of the amplitude of the companion's radial velocity variation yields a determination of the mass ratio of the two components. Existing data lead immediately to the presumption that the metal deficiency of χ Dra A is slight, so that high precision is necessary if one is to show that such a deficiency exists. With this in view, inasmuch as χ Dra A is of a spectral type close to the sun's, a strictly differential method was adopted. The lines of the stellar spectrum were compared to those of the sun using spectra of the moon obtained under the same conditions as the stellar spectra. Study of the metallic lines combined with the value of the absolute magnitude of the star yields a relation $g = f(\theta \text{ eff})$ between the gravities and effective temperatures possible for χ Dra A. A series of models was constructed following this relation and the computed line profiles were fitted (hydrogen and metallic lines) to the observed profiles; in each case it was verified that the solar model homologous to that of χ Dra reproduces the solar lines correctly, using the same atomic constants. The effective temperature, the abundance of the various metals, and the microturbulent velocity, with high accuracy were thus determined. The microturbulent velocity is identical to that of the sun, and so cannot explain the ultraviolet excess of this star. In contrast, the elements of the iron peak are underabundant by a fac-

tor two with respect to the sun. Barium seems to be less rare than the other heavy elements. (auth)

28913 NONGRAY MODEL ATMOSPHERES OF SOLAR-TYPE STARS. II. THE SOURCE OF OPACITY IN THE ULTRAVIOLET CONTINUUM AND ITS EFFECT ON THE RADIATION FIELD IN THE OTHER SPECTRAL REGIONS. Matsushima, Satoshi (Tokyo Univ. Univ. of Iowa, Iowa City); Terashita, Yoichi. Ann. Astrophys., 30: 189-205(Mar.-Apr. 1967).

Following the Avrett–Krook iteration procedure, a number of nongray model atmospheres with varying opacity sources were constructed for solar-type stars, with the particular aim of investigating the yet-unknown source of absorption in the ultraviolet continuum and its effect on the atmospheric structure, especially on the radiation field in the visible and infrared regions. Among them, four basic models constructed for the same boundary conditions and chemical composition, but with different continuous opacities, are discussed in reference to observations of the solar limb darkening and the absolute intensity distribution with wavelength at the center of the solar disk. Models I and II include H and H^- only as the sources of absorption but differ by 10 to 50% in the adopted values of the H^- absorption coefficient. Absorption by the metals is included in addition to H and H^- in Model III, and a still larger opacity is added in Model IV so as to have satisfactory agreement with observations. (auth)

28914 CHARACTERISTIC TIMES OF ESTABLISHMENT OF THERMAL EQUILIBRIUM IN DEGENERATE MATTER. Baglin, A. (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 185-8(Mar.-Apr. 1967). (In French).

The thermal equilibrium hypothesis for very dense stars is examined and discussed. The characteristic time for the propagation of a thermal perturbation in degenerate matter is estimated. (auth)

28915 EXACT DETERMINATION OF THE STATIONARY STRUCTURE OF A HYDROGEN ATMOSPHERE. PROBLEM OUTSIDE OF LOCAL THERMODYNAMIC EQUILIBRIUM. Cuny, Y. (Observatoire de Meudon, France). Ann. Astrophys., 30: 143-83(Mar.-Apr. 1967). (In French).

Theoretical study of the departures from local thermodynamic equilibrium in a stellar atmosphere leads to the simultaneous resolution of the equations of statistical equilibrium and the equations of transfer of radiation. This study deals with the resolution of these two coupled systems of equations. After giving the classical expressions for the number of atomic collisional and radiative excitation and de-excitation processes, as well as those for the absorption and emission coefficients, the statistical equilibrium equations are formulated. The expression of the source function in a line which is derived from the coefficients of the statistical equilibrium equation is recalled, and the differential radiative transfer equations are formulated. These equations may be linearized in part for a set of transitions originating in the same lower level. The method of numerical integration of the system of linear differential equations of radiative transfer is considered. The solutions of the equations of transfer are explained, particularly at great depths, and the influence of the absorption and emission profiles on these solutions is shown. The iterative procedures used to solve completely the two coupled systems of equations of statistical equilibrium and of radiative transfer are described. The method is applied to a semi-infinite plane parallel medium, of pure hydrogen at constant temperature and pressure. The case of a one-, two-, and three-level atom is treated, and the coupling between the transitions is studied. (auth)

28916 THEORY OF STELLAR CLASSIFICATIONS. I. CONSTRUCTION OF MODELS IN LOCAL THERMODYNAMIC EQUILIBRIUM. Feautrier, Paul (Observatoire de Paris). Ann. Astrophys., 30: 125-41(Mar.-Apr. 1967). (In French).

A new method for the construction of model atmospheres in radiative and thermodynamical equilibrium is reported. This method is an extension to non-gray problems of the method of discrete ordinates of Chandrasekhar, and uses a technique of Fox to handle the resulting system of differential equations with two-point boundary conditions. The method was applied to the construction of a grid of model atmospheres in the range: $5{,}000°K \leq T_{eff} \leq 50{,}000°K$, $300 \leq g \leq 100{,}000$. The Balmer jump and the ultraviolet gradient computed from these models agree fairly well with observations of Chalonge and his group; however, the agreement is not so good for the blue gradient. (auth)

28917 THE SPECTRUM OF THE CEPHEID RU CAMELOPARDALIS. Faraggiana, Rosanna; Hack, Margherita (Osservatorio Astronomico, Trieste, Italy). Z. Astrophys., 66: 343-63 (1967).

Eleven spectrograms, dispersion 9 A/mm, spectral range λλ 3600 to 5000, taken between Feb. 1956 and May 1961 were studied. The radial velocity measurements show evidence of stratification. The presence of an expanding chromosphere or prominence field is indicated by the high negative velocity of the emission components of Ca II, H, and K. The quantitative analysis gives the following results: $\Theta_{exc}(Fe\ I) = 1.11$, $\log P_e = -0.5$, $\log v = 0.45$, at maximum light, and $\Theta_{exc} = 1.3$, $\log P_e = -1.25$, $\log v = 0.52$ at minimum light. In spite of the fact that RU Cam is a population II cepheid, with $M_v = -2.8$ (from the width of the H and K emission lines), located at a height of 1200 pc above the galactic plane, the metallic abundance is almost normal, with a slight excess by a factor of 2 or 3 for Ca, Ti, V, Ni, and the rare earths with respect to Fe. The excess of carbon is not greater than 2 or 3. From the intensities of the Balmer lines it can be estimated that RU Cam is not hydrogen-poor. The ratio $^{12}C/^{13}C$ is of the order of 9. (auth)

28918 THE CYGNUS X REGION II. ADDITIONAL OBSERVATIONS AT 610.5 MHz. Wendker, H. (Univ. of Illinois, Urbana). Z. Astrophys., 66: 379-89(1967).

The results of observations of the Cygnus X region at 610.5 MHz between declinations +42.5 and +44° are presented; 25 sources were found. New or better spectra are obtained for 15 of these sources by comparison of the new data with observations at higher frequencies. One source is partly optically thick, and four sources seem to be nonthermal. The distance to the sources is discussed briefly. The red prints of the Palomar Sky Survey were used to identify the sources with optically visible nebulae. (auth)

28919 THE LASER-LIKE NATURE OF TYPE I SOLAR RADIO BURSTS. Mogilevskii, E. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 625-8(1966).

Translated from Geomagn. Aeronomiya, 6: 809-14(1966).

A hypothesis is advanced that narrow-band type-I radio bursts owe their existence to magnetic-dipole transitions on split Zeeman sublevels of solar-corona hydrogen atoms in the ground state. "Optical pumping" can occur because of the resonance scattering of L_α quanta from the chromosphere and "depopulation" can result from induced transitions under the influence of enhanced polarized radio emission in the metric range. The characteristics of type-I radio bursts are explained. (auth)

28920 QUASARS AND COSMOLOGICAL MODELS. Reinhardt, Michael V. (Univ., Tuebingen, Ger.). Z. Astrophys., 66: 292-300(1967).

The U, B, V values and redshifts of 43 QSS are interpreted in two cosmological models, namely the steady state theory and a Friedman universe with the deceleration parameter $q_0 = +1$. The method follows an analysis of McCrea (1966) of only 15 objects. The results indicate an evolutionary effect with redshift in the steady-state model. This is an argument against the steady-state theory, provided the sources are "cosmological." The observations do not contradict a Friedman universe, so that the evolutionary model appears to be quite acceptable. (auth)

28921 NONEXISTENCE OF CLUSTERS OF CLUSTERS OF GALAXIES. II. Karpowicz, Maria (Univ. of Warsaw). Z. Astrophys., 66: 301-7(1967).

The distribution of clusters of galaxies was analyzed as they are listed in Volume II of Catalogue of Galaxies and Clusters of Galaxies of Zwicky and Herzog, 1963. It was found that the distribution is random and essentially uniform. No indications were found for the existence of any systematic clustering of clusters of galaxies. (auth)

28922 VELOCITY DISPERSIONS IN A MASS MODEL OF THE GALACTIC SYSTEM. Innanen, K. A. (York Univ., Toronto); Fox, D. R. Z. Astrophys., 66: 308-13(1967).

Velocity dispersions, numerically calculated from a recent galactic mass model (Innanen, 1966), are presented. The general result that the z-velocity dispersion increases with increasing spheroid axial ratio is reproduced, but within each spheroid, the z-velocity dispersion is found to decrease with increasing z. (auth)

28923 INFLUENCE OF EMISSION LINES ON THE COLOR INDICES OF QUASISTELLAR OBJECTS. Gail, H.-P.; Lamla, E.; de Vegt, Chr. Z. Astrophys., 66: 324-20(1967). (In German).

From recent scanning-observations of quasistellar objects by J. B. Oke (1966), a mean intensity distribution in the wavelength region $1000\ Å \leq \lambda \leq 7200\ Å$ was constructed. By modification of the different emission lines their influence on the color index as a function of z was studied. It is shown that this relation and the position of the quasistellar objects in the two-color-diagram are mainly determined by these emission lines. (auth)

28924 COMPTON-EFFECT CALCULATIONS FOR ASTROPHYSICAL APPLICATIONS. Baylis, William E.; Schmid, Wolfgang M.; Luescher, Edgar (Max-Planck-Institut fuer Extraterrestrische Physik, Garching, Ger.). Z. Astrophys., 66: 271-91(1967).

An expression is derived for the energy–differential cross sec-

tion for Compton scattering, $d\sigma(\Omega, \omega')/d\omega'$, in which Ω gives the direction of the incoming photon, and ω' is the energy of the scattered photon. The asymptotic forms for small and large electron velocities are developed, and the average values over Ω are calculated and plotted for four different photon distributions, $\psi(\Omega)$. It is shown that the photon distribution can strongly influence the energy dependence of the average cross section. With an isotropic distribution: $\psi(\Omega) = 1/4\pi$, Ginzburg and Syrovatski's approximation is obtained. The distribution of scattered-photon energies for an electron energy spectrum of the form $\gamma^{-\alpha}$ is shown for all cases considered to have the form $\omega'^{-(\alpha+1)/2}$, independent of the energy distribution of initial photons. Results are also given for a more general electron spectrum. Recent measurements of the galactic radio emission by Purton are used to determine and x- and γ-ray spectrum which agrees satisfactorily with observational data. The effect of Compton scattering on electron spectra is studied and is shown to cause a relative decrease in intensity at high energies. Synchrotron radiation, viewed as arising from Compton scattering of electrons with virtual photons of a magnetic field, and polarization in Compton radiation are discussed in the appendices. (auth)

28925 RELATIVISTIC COLLAPSE TO A SCHWARZSCHILD SPHERE. Wahlquist, H. D.; Estabrook, F. B. (California Inst. of Tech., Pasadena). Phys. Rev., 156: 1359-64(Apr. 25, 1967).

Analytical models of spherically symmetric, nonstatic processes, including relativistic collapse to, and explosion from, a central body, are constructed by joining three simple space–time metrics across surfaces of discontinuity. The tetrad or dyadic formulation of the junction conditions, implied by the postulate of admissible coordinates, is employed to match the solutions. (auth)

28926 FREQUENCY DEPENDENCE OF RADIO STAR SCINTILLATIONS. Aarons, Jules (Air Force Cambridge Research Labs., Bedford, Mass.); Allen, Richard S.; Elkins, Terence J. J. Geophys. Res., 72: 2891-2902(June 1, 1967).

The amplitude scintillations of the radio flux from Cygnus and Cassiopeia were studied at discrete frequencies in the vhf–uhf range (30, 63, 113, 228, and 400 Mhz) using 150-foot and an 84-foot diameter steerable paraboloids, both independently and in an interferometer mode. Data at various combinations of these frequencies were collected over a period of $3\frac{1}{2}$ years and analyzed to establish the frequency dependence of ionospheric scintillations. For weak scintillations (the higher frequencies during periods of low magnetic activity) the scintillation index is found to be inversely proportional to (frequency)^2. For lower frequencies and high levels of ionospheric activity, the dependence approaches $1/f$. These results agree with predictions based upon a simplified theory of weak scattering in the medium and assuming various combinations of irregularity size and height of the disturbing layer. Measurements made with the two antennas in an interferometer configuration established that the diffraction field was truly random as assumed. Correlation coefficients were obtained for discrete sets of data and a distinction made between weak and strong scattering cases. Irregularity sizes of about 1–2 km were found to be consistent with the bulk of the observations, on the basis of weak scattering theory. (auth)

28927 NITROGEN LINES IN THE INFRARED FRAUNHOFER SPECTRUM. Swensson, J. W. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg., 52: 1306-9(1966).

The laboratory investigations by Eriksson and by Eriksson and Johansson of the infrared arc spectrum of nitrogen constitute in part the basis for a discussion of the spectroscopic evidence for the presence of nitrogen in the sun. The solar material consists mainly of measurements of high-resolution spectrophotometric records of the Fraunhofer spectrum obtained by Delbouille and Roland. These data have been supplemented by the information furnished by the solar tables prepared by Babcock and Moore and by Mohler. A table giving laboratory and solar data pertaining to the leading N I multiplets lists 38 lines that have been referred wholly or partly to nitrogen atoms in the atmosphere of the sun. Twenty-eight of the N I identifications are new, but four of these are subject to varying degrees of doubt. The maximum excitation potential for nitrogen lines in the solar spectrum is found to be 12.36 eV, which is 0.6 eV higher than the value previously supposed. (auth)

28928 EVIDENCE FOR LARGE-SCALE CLUSTERING OF FAINT RADIO SOURCES. Ceccarelli, M.; Grueff, G. (Univ., Bologna). Nuovo Cim. (10), 48B: 425-8(Apr. 11, 1967).

A new method for data processing was developed for the study of the statistical properties of radiosource angular distributions, in order to detect possible deviations from a strictly random distribution. The method is described, together with some preliminary results, indicating that the "clustering" effect cannot be due to drifts of the receiving system or to other instrumental effects of this type. (M.H.R.)

28929 POSSIBILITY OF SELECTING QUASI-STELLAR GALAXIES FROM BLUE STARS BY OBSERVATIONS IN THE NEAR INFRA-RED. Braccesi, A. (Laboratorio Nazionale di Radioastronomia, Bologna. Univ., Bologna). Nuovo Cim. (10), 49B: 148-50(May 11, 1967).

A preliminary test was conducted with the 48-inch Schmidt telescope at Palomar. A two-color, U–B plate and an infrared plate were obtained of a field near the north galactic pole. At a first inspection it seems that the objects showing ultraviolet excess can be easily divided into two classes according to the intensity of the infrared images. Some examples are shown. (W.D.M.)

28930 2800 MHz RADIO EMISSION FROM ELEVEN QUASI-STELLAR GALAXIES. Braccesi, A. (Univ., Bologna). Nuovo Cim. (10), 49B: 151-3(May 11, 1967).

Faint radioemission was detected from a sample of eleven quasi-stellar galaxies using the Owens Valley Radio Interferometer at a frequency of 2800 mHz. Three 20-min observations were obtained for each object using a 200-ft east–west baseline, and various hour angles. The observing procedure and the subsequent reductions allowed both the amplitudes and the phases of the interferometer fringes to be measured. Accurate positions of the objects were obtained from a 48-inch Schmidt plate. The positions and radio data are listed. (W.D.M.)

28931 408 MHz RADIO EMISSION FROM ELEVEN QUASI-STELLAR GALAXIES. Fanti-Giovannini, C.; Fanti, R. (Univ., Bologna). Nuovo Cim. (10), 49B: 154-5(May 11, 1967).

Sandage and Luyten (Astrophys. J. (in press)(1967)) have measured the spectra of 11 quasi-stellar galaxies. A survey was made around the positions of these QSG's with the east–west arm of the "Northern Cross" at a frequency of 408 MHz and with a resolving power of 4 min in right ascension and 100 in declination. Three scans were made for each object. No radiosource was found at the positions of the QSG's having flux densities greater than the limit set by confusion. (W.D.M.)

28932 PECULIAR VELOCITY OF THE SUN AND THE COSMIC MICROWAVE BACKGROUND. Sciama, D. W. (Columbia Univ., New York. New York Univ., New York). Phys. Rev. Lett., 18: 1065-7(June 12, 1967).

The sun's peculiar velocity with respect to distant galaxies is roughly estimated from the red-shift data for nearby galaxies to be ~400 km/sec toward $l_{II} \sim 335°$, $b_{II} \sim 7°$. Future observations on the angular distribution of the cosmic microwave background should be able to test this estimate, if the background has a cosmological origin. If the test is successful it would imply that a "local" inertial frame is nonrotating with respect to distant matter to an accuracy of 10^{-3} sec of arc per century, which would represent a 5000-fold increase of accuracy. (auth)

28933 MEASUREMENT OF THE COSMIC MICROWAVE BACKGROUND TEMPERATURE AT 1.5-cm WAVELENGTH. Welch, W. J.; Keachie, S.; Thornton, D. D.; Wrixon, G. (Univ. of California, Berkeley). Contracts Nonr 222(54); AF19(628)-5884. Phys. Rev. Lett., 18: 1068-70(June 12, 1967).

Penzias and Wilson reported observing an excess antenna temperature of 3.5 ± 1°K at a wavelength of 7.4 cm, a finding which was interpreted by Dicke et al. as evidence of red-shifted thermal radiation emitted during a compact early stage of the universe. Measurements reported subsequently are summarized. A measurement of the background temperature at 1.5 cm is reported which resulted in a value of 2.0 ± 0.8°K. The apparatus used for the observations consisted of a small pyramidal horn of 12° bandwidth connected to a conventional Dicke radiometer. (W.D.M.)

28934 DISCRETE RADIO SOURCES AT 38 Mc/s. Slee, O. B. (Royal Radar Establishment, Malvern, Eng.); Wraith, P. K. Nature, 214: 971-4(June 3, 1967).

Long baseline interferometer observations, between Jodrell Bank and the Royal Radar Establishment, Malvern, England, of thirty-four radio sources have provided valuable information about radiosource structures. Ionospheric and interplanetary scattering effects are present at 38 Mc, but do not prevent high-resolution studies of sources. (auth)

28935 ELECTRICAL FIELD IN SOLAR ATMOSPHERE CAUSED BY PRESSURE GRADIENT. Kopecky, M.; Kuklin, G. V. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Bull. Astron. Inst. Czech., 18: 77-82(1967).

The expression for the electric field strength E caused by a pressure gradient is specified in the case of partially ionized gas. Calculations of E for various values of the effective cross section

ratio r_{in}^2/r_{en}^2 at different levels of the solar atmosphere were made. The following estimations were found: Photosphere $10^{-11} \sim 10^{-10}$ CGSE, sunspot $10^{-12} \sim 10^{-10}$ CGSE, facula $10^{-11} \sim 10^{-10}$ CGSE, corona $10^{-12} \sim 10^{-9}$ CGSE. (auth)

28936 TYPE-IV BURSTS. III. IN ASSOCIATION WITH FORBUSH EFFECTS. Svestka, Z. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 18: 55-61(1967).

Eighty-five Forbush decreases associated with type-IV burst flares listed in Part I are discussed, particularly in relation to the PCA events investigated in Part II. The three main conclusions of this discussion can be summarized as follows: (1) The productivity of Forbush effects by type-IV burst flares strongly increases with the increasing importance of the associated PCA event. This proves that the space density of high-energy particles can only be high if the total density of particles inside the cloud is high. (2) The delay times of GLE's, PCA's, and Forbush decreases show one common characteristic: if the effect is strong, the delay time is always short. A short delay time itself, however, does not mean that the effect is strong. An explanation of this characteristic feature is given. (3) While there are very few flares producing strong PCA's to the east of the solar central meridian and the vast majority of strong PCA events is caused by flares situated on the western solar hemisphere, the majority of flares producing major cosmic-ray storms are on the eastern hemisphere of the Sun. Flares nearer to the western limb than 50°W, very efficient in producing strong PCA's, are entirely inactive in producing major cosmic-ray storms. It is shown that one can explain this longitude distribution of flares producing Forbush effects and/or PCA's when assuming an asymmetrical distribution of the magnetic field inside the cloud of the ejected particles, with a strong magnetic western boundary of the cloud. (auth)

28937 THE PHOTOSPHERIC SITUATION CONNECTED WITH THE DEVELOPMENT OF FLARES ACCOMPANIED BY THE TYPE-IV RADIO BURSTS. Antalova, A. (Astronomical Inst., Slovak Academy of Sciences, Skalnate Pleso). Bull. Astron. Inst. Czech., 18: 61-7(1967).

Large bipolar F-type sunspot groups, if isolated, are not a favorable region for the formation of powerful flares. For 148 type-IV burst flares the configuration of the corresponding sunspot groups was determined. They may be divided into 7 types: Comp., H', HE, E', R, 2F, and F'. The distribution is given and the configurations in question are described. From the characteristic features of the seven configurations flares with importance higher than 3 are forecasted. The distribution of the area of sunspots and flares on a time–latitude scale is given. (auth)

28938 IMPURITIES IN INTERSTELLAR GRAINS. Hoyle, F.; Wickramasinghe, N. C. (Univ. of Cambridge, Eng.). Nature, 214: 969-71(June 3, 1967).

It is shown that the presence of impurity atoms in interstellar grains can drastically change the interaction of the grains with electromagnetic radiation over a wide range of wavelengths, extending from the optical to the far infrared. (UK)

28939 ON THE ACTIVE REGION CORONA AND THE INTERPRETATION OF TYPE I BURSTS. Elgaroey, Oeystein; Eckhoff, Hans Kr. Astrophys. Norv., 10: 127-48(Sept. 1966).

Noise storms originate in the corona above active photospheric regions. From optical observations a large amount of information has been collected about the physical properties of the active-region corona. A review of results which may be relevant for the interpretation of the noise storm phenomenon is given. It is supposed that the bursts are generated by coherent plasma oscillations excited by an electron beam. When the duration of the bursts is assumed equal to the deflection time of the beam particles, it is found, using current values of the observed burst duration at different frequencies, that the beam velocity on the average is higher at the higher frequencies than at the lower ones. Thus the acceleration is higher at lower heights above the photosphere, and this may indicate a connection between the beam velocity and the strength of the magnetic field. A discussion of the deduced beam velocities leads to the conclusion that the temperature in the burst source must be relatively low, in the range from about 0.5×10^6 to 10^{9}K, and it is suggested that type-I bursts are generated in "cold" filaments. For short-lasting bursts, Landau damping may be important. The observed bandwidth of the bursts may be due to the combined effect of a density variation across the source and a velocity dispersion in the exciting beam. Typical average values are $\Delta N_e/N_e = 2\%$ and $\Delta v_0/v_0 = 10\%$. Thus very uniform conditions must prevail in the source. Since the active corona is very inhomogeneous, the source must be small and this strengthens the suggestion that the burst source is confined to filaments, where a strong, ordered magnetic field imposes a high degree of uniformity. A frequency drift may be caused by a variation of the electron density, or the temperature or both along the path of the exciting beam. Since a temperature gradient of the correct magnitude seems less probable, the effect of a density variation is the most important. Most type-I bursts show no frequency drift. Hence the density gradient of the filaments in the direction normal to the solar surface is smaller than the average in the active region, or the path of the exciting disturbance is in most cases nearly parallel to the solar surface. Finally, some comments are made on an event in which a decrease in the burst duration occurred and most bursts showed a fast frequency drift to higher or lower frequencies. The event probably reflects a perturbation of the noise-active region, during which the magnetic field strength decreased and large density gradients temporarily were set up. (auth)

28940 INVESTIGATION OF SHORT-WAVE EDGE OF SOLAR SPECTRUM RECORDED BY SATELLITES AND ROCKETS. Mandel'shtam, S. L.; Vasil'ev, B. N.; Voron'ko, Yu, K.; Tindo, I. P.; Shurygin, A. N.; Fetisov, E. N. (Lebedev Inst. of Physics, Moscow). Glas. Hem. Drus., Beograd, 30: 141-51(1965). (In Russian).

The short-wave length edge of the solar spectrum produced by the corona and extended up to 10 Å was measured, using a beryllium foil and a thin mica photon counter installed in a rocket. The x radiation was recorded at about 92 km above the earth, with a fast drop of intensity of wavelengths below 10 Å. The energy flow at 10 Å was 7.3 to 3.2×10^{-4} erg/cm^2 sec; for a second satellite flow was measured as 7 to 8×10^{-4} erg/cm^2 sec, and for a third, 2 to 3×10^{-4} erg/cm^2 sec. Correlation of the data with temperature indicates the nonuniform character of the corona, i.e., condensed regions with higher particle densities and higher temperatures. (R.V.J.)

28941 ON THE POSSIBILITY OF THE CONJUNCTION OF THE EARTH'S MAGNETIC FIELD WITH A SOLAR MAGNETIC BOTTLE. Krivsky, L. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 18: 83-8(1967).

It has been shown previously that at moderate geomagnetic latitudes, and after considerable solar flares, it is possible for high-velocity particles (and also for some slower corpulcles) to penetrate as far as the lower ionosphere. The possibility of the direct penetration of solar particles, having velocities of 10^3 to 10^4 km/s, in the lower ionosphere is discussed here. This application is in keeping with Sweet's mechanism (1958), which could be explained by annihilation and the conjunction of two systems of magnetic fields with particle flows for the interaction of corpuscular clouds with the Earth's magnetosphere. In an application of the Syrovatskii criterion (1966) an accumulation and acceleration of the particles along the Y axis can occur in the "neutral-point" of the conjunction. The particles can come from the magnetic guiding and part of them can penetrate even to the low ionosphere. A possibility of overcoming the magnetic barrier by the penetration of the particles deep in the ionosphere, by forming of some sort of channels, is indicated. In several cases, when corpuscular clouds causing the Forbush effects and geomagnetic storms are present, it is believed that the earth's magnetic field spreading from the poles to moderate latitudes is joined by a magnetic bottle with the active solar region. This principle allows for very easy guidance of cosmic and subcosmic particles along the limb of the cloud from flares in the same active solar region to the Earth. (auth)

28942 SUNSPOT APPEARANCE AND STARS WITH PULSATING MAGNETIC FIELD FROM JENSEN'S THEORY OF MAGNETIC TUBES. Chvojkova, E. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 18: 89-93(1967).

Results are presented, based on Jensen's theory of magnetic toroids (concentric with solar or stellar surface), which maintain a constant mass, have a smaller density than the external plasma, and are affected only by temperature, pressure and their gradients (including the gravity effect). All other effects are neglected. The magnetic flux has been put inversely proportional to the torus radius, a; this slight modification of one of Jensen's formulae made it possible to investigate the behavior of magnetic tubes with largely varying torus radii. Applying the results to stars with variable diameter, it is found that the magnetic tube drifts and expands at the same rate as the star and that the magnetic field varies with the density (proportional to a_*^{-3}). When applying Jensen's formulae to the Sun, it is found that only at the upper boundary of the photosphere is the gradient of temperature high enough to accumulate and maintain a considerable quantity of magnetic tubes. A small change in temperature can shift this accumulation level upwards, thus providing good conditions for the appearance of sunspots. The tubes need not coincide with the equator. (auth)

28943 OBSERVATIONS OF THE ANDROMEDA GALAXY AT 11-CENTIMETER WAVELENGTH. Cooley, R. C. (Univ. of Illinois, Urbana); Roberts, M. S.; Swenson, G. W. Jr. Science, 156: 1087-8(May 26, 1967).

Observations of the Andromeda galaxy (M31) at 2695 MHz reveal more detail than do earlier measurements at lower frequency. The region is highly confused but there is apparently a more dense clustering of sources within the optical outline of the galaxy than without. One source (OA33) near M31 has an interesting, flat spectrum. (auth)

28944 ISOTROPY OF COSMIC BACKGROUND RADIATION AT 4080 MEGAHERTZ. Wilson, R. W.; Penzias, A. A. (Bell Telephone Labs., Holmdel, N. J.). Science, 156: 1100-1(May 26, 1967).

An 18-hour-long record made as part of a program of measurements of the fluxes of a number of discrete radio sources was examined. Since the radiometer employed an absolute reference, it was possible to obtain absolute background data from the reference region observed around each of the 29 sources investigated that day. From the study of a plot made from this data, it was concluded that there is no large-scale deviation from isotropy of more than 0.1°K at 4080 MHz. (auth)

28945 ROTATION OF THE SUN. Goldreich, Peter (California Inst. of Tech., Pasadena); Schubert, Gerald. Science, 156: 1101-2(May 26, 1967).

Dicke has interpreted his recent measurement of the Sun's oblateness as implying a fast (1.8-day period) rotation of the solar radiative interior. It is found that differentially rotating solar models, such as the one proposed by Dicke, are unstable. The rate of turbulent diffusion in the unstable regions of these models is so rapid that it appears to preclude a fast-spinning solar interior. As a corollary of the stability analysis, it is concluded that the loss of a significant fraction of a star's angular momentum must be accompanied by the mixing of material below its convective zone. Such mixing inevitably leads to the depletion of lithium in the star's photosphere. (auth)

28946 TYPE-IV BURSTS AND ASSOCIATED ACTIVE REGIONS. Kleczek, J.; Olmr, J. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 18: 68-9(1967).

From observations during the last minimum it seems, that the type-IV bursts evade isolated sunspot groups and prefer active regions with two or more spot groups. (auth)

28947 INVESTIGATION OF SOLAR RADIO BURSTS IN THE FREQUENCY RANGE 536 TO 2000 Mc. Tlamicha, A. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov); Olmr, J.; Fuerstenberg, F.; Krueger, A. Bull. Astron. Inst. Czech., 18: 70-7(1967).

A statistical investigation of solar dm bursts was made using single-frequency observations at 536, 808, 1500, and 2000 Mc. A total of 1620 bursts of the years 1959 to 1961 was examined. Bursts of small bandwidth increasing with wavelength and including both continuum and noncontinuum radiation were found. The dm bursts were compared with associated cm and meter bursts, chromospheric flares, and SIDs. The association between m-type-III bursts and dm bursts increases with increasing frequency, as well as with wavelength of the dm bursts. The percentage of flare associations increased with frequency, indicating that at 2000 Mc there may exist a certain amount of non-flare associated bursts. Average spectra for different kinds of dm bursts were derived and different burst characteristics are discussed. (auth)

28948 NEUTRON CAPTURE AND STELLAR SYNTHESIS OF HEAVY ELEMENTS. Gibbons, J. H.; Macklin, R. L. (Oak Ridge National Lab., Tenn.). Science, 156: 1039-49(May 26, 1967). (ORNL-P-2800).

The neutron-buildup processes of heavy-element synthesis in stars by studying the correlations between abundance and neutron-capture cross section is discussed. Measurement of these cross sections has required the development of new techniques for measuring time of flight of pulsed neutron beams. These developments are described in some detail. The correlations have been used for obtaining an independent measure of the time that has elapsed since the solar system was synthesized. S-process correlations and tests of the s-process theory are discussed. (W.D.M.)

28949 QUASARS: THEIR IMPORTANCE IN ASTRONOMY AND PHYSICS. Kahn, F. D.; Palmer, H. P. Cambridge, Mass., Harvard University Press, 1967. 118p. $5.50.

This book is based on a series of lectures given at Manchester in November 1965. The material has been revised to take account of the changes that have occurred since Nov. 1965. Topics covered include radio galaxies, discovery of quasars, optical properties of quasars, radio properties of radio galaxies and quasars, dynamics, relativity, cosmology, stars, electron processes, production of fast particles, synthesis of the elements, and quasar models. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 29347, 29349, 29512, 29589, 29700, and 30052.

28950 (AAEC/TM-349) LOW ENERGY SPUTTERING SYSTEM. Rose, A.; Broe, H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1966. 11p. Dep.

A description is given of a low-energy sputtering system for producing thin films for use as nuclear particle targets. (auth)

28951 (AFCRL-67-0165) AN APPROACH TO THE BOUND-STATE THREE-BODY PROBLEM WITH APPLICATION TO THE HELIUM-LIKE ATOM. Jasperse, J. R. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Jan. 4, 1967. 96p. (CONF-660811-4).

From American Physical Society Meeting, Mexico City, Mexico.

A technique is presented for treating a general type of three-body bound-state problem for situations where the interaction may be written as the sum of three pair potentials. The method is based on the work of Eyges (1959, 1961, 1965) and consists of writing the total wavefunction for the three-body problem in a special form, that is, as the sum of three different parts or "orbitals" defined in a natural way from the integral equation by using the appropriate symmetrized or antisymmetrized Green's function. A set of three integral equations for the three orbitals is derived: first for the situation where each particle is distinguishable, and then for situations where two or all of the three particles are identical. It is found that, when some of the particles are identical and the Pauli principle is incorporated into the formulation, the number of independent orbitals can be reduced. Some simple one-dimensional applications are examined. The first involves δ-function pair potentials including an example where one of the pair interactions is repulsive. The second involves the one-dimensional problem of three identical spinless particles interacting through attractive, square-well potentials. These applications are discussed in order to illustrate a general approach to the above-mentioned set of coupled integral equations. The helium atom is discussed from a three-body point of view. Each orbital is expanded into a complete set of two-body Sturmian functions for the Coulomb potential. For states in atomic helium of the form $L = 0$ the equations assume a simplified form. For these states, the infinite set of integral equations generated by the expansion is truncated at several orders and solved numerically. Rapid convergence is demonstrated for low-lying states of the helium-like atoms using this method. In particular, results are reported for the $1s1s^1S$, $1s2s^1S$ and $2s2s^1S$ states of He, Li^+, and H^-. The technique is not based upon a perturbation expansion or a variational principle. (auth)

28952 (BNL-11368) IONIZATION LOSS, RANGE, STRAGGLING, AND MULTIPLE SCATTERING. Huson, F. R. (Brookhaven National Lab., Upton, N. Y.). [1966]. 56p. Dep. CFSTI.

The various formulas and tables necessary for the geometry and kinematics programs for a mixture of H_2–He in a bubble chamber were calculated. The formulas were generalized so that they can be used for any molecular composition. In particular, formulas are given for dE/dx, range, straggling error, error from density, multiple scattering error, and radiation length. The FORTRAN program for calculating all these quantities for any given material is given. (M.O.W.)

28953 (CERN-67-15) ARE PHOTON–PHOTON SCATTERING EXPERIMENTS FEASIBLE? Csonka, Paul L. (European Organization for Nuclear Research, Geneva (Switzerland)). May 11, 1967. 29p. Dep.

The significance of photon–photon scattering experiments and the experimental possibilities are discussed. The following techniques are mentioned: laser beams clashed with high energy γ-ray beams, flash x-ray machines, nuclear explosions, synchrotron radiation, clashing γ-ray beams. (auth)

28954 (COO-1674-2) AN ANALYSIS OF DATA ON DOUBLE TRANSITIONS IN He. Chock, David P.; Fano, U. (Chicago Univ., Ill. Dept. of Physics). [1966]. Contract AT(11-1)-1674. 17p. Dep. CFSTI.

A summary and comparison of information from various experimental and theoretical sources on the probability of double electron jumps in helium are given. Data from photon and particle bombardments were analyzed. (M.O.W.)

28955 (GA-7948) SMALL-ANGLE SCATTERING IN CHARGE-TRANSFER COLLISIONS BETWEEN He^+ AND Ar AT ION ENERGIES BETWEEN 80 AND 300 eV. Fleischmann, Hans H.; Young, Robin A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 17, 1967. 8p. (CONF-670702-5).

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR.

The angular distribution of fast helium atoms resulting from the reaction $He^+ + Ar \rightarrow He + Ar^+$ has been measured for energies of 80 to 300 eV and scattering angles up to 10°. The results show a dip in forward direction and an oscillatory structure around it. The position of the first maximum varies proportionally with the energy. (auth)

28956 (JINR-P1-3255) ZAKHVAT OSTANOVIVSHIKHSYA π^--MEZONOV V SMESI GELIYA-3 I ZOTA. (The Capture of Stopped π^--Mesons in the Mixture of ^{3}He and Nitrogen). Petrukhin, V. I.; Prokoshkin, Yu. D.; Filippov, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 6p. (In Russian). Dep.

The yields of π^0 mesons, produced by the stopping of π^- mesons in the mixture of helium-3 and nitrogen, are measured. It is shown that the capture of π^- mesons by helium-3 and nitrogen atoms is proportional to the stopping power of atoms. (auth)

28957 (NASA-TN-D-3997) STATUS OF POROUS IONIZERS FOR CONTACT IONIZATION OF CESIUM. Headley, Larry C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1967. 28p. CFSTI.

Much of the recent information obtained from tests of materials under consideration for use as porous ionizers in cesium ion sources and cesium ion thrustors is summarized. The information presented for the various materials includes sintering characteristics, pore densities and diameters, work functions, emittances, methods of manufacture, and ionization performance. The ionization performance is described by including graphs of ion-current density against critical temperature, neutral fraction against critical temperature, and ion-current density against neutral fraction. (auth)

28958 (SSD-TR-67-34) EFFECT OF A MAGNETIC FIELD ON THE SPACE CHARGE NEUTRALIZATION PROBLEM IN ELECTRIC PROPULSION. Meyer, Rudolf X.; Kramer, Raymond F. (Aerospace Corp., El Segundo, Calif.). Feb. 1967. Contract AF04(695)-1001. 41p. (TR-1001(2250-50)-2).

Some basic aspects of ion beam neutralization in the presence of magnetic fields are investigated. The problem leads to an integro-differential equation for the electrostatic potential. This equation is solved numerically for several values of the electron–ion mass ratio. Of more interest for practical applications is the limit as the mass ratio tends to zero. In this case, the governing equation becomes linear and the problem reduces to finding the inverse of a Hilbert transform. The solution can be expressed in terms of elementary functions. Among the results obtained are the distribution of the charge densities for electrons and ions in the beam, and the electron trajectories. The limiting condition for beam reversal, which applies when the magnetic field is sufficiently strong to prevent the electrons from being drawn into the beam, is determined. Also computed is the loss in propulsive efficiency due to "electron swirl." Finally, it is pointed out that this loss can be entirely avoided if a magnetic field is employed whose transverse component changes direction. (auth)

28959 (UCRL-17314) CALCULATION OF STOPPING POWER AND RANGE-ENERGY VALUES FOR ANY HEAVY ION IN NONGASEOUS MEDIA. Steward, Palmer G.; Wallace, Roger (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 20, 1966. Contract W-7405-eng-48. 54p. Dep. CFSTI.

A method is presented for calculating range–energy and stopping-power data for any heavy ion with $0.01 \leq \epsilon \leq 500$ MeV/amu incident upon any nongaseous stopping medium. The method is incorporated into a FORTRAN computer program. Results for H, ^{4}He, ^{12}C, ^{20}Ne, ^{40}Ar, ^{84}Kr, ^{131}Xe, and ^{238}U ions each incident upon H_2O, Al, Cu, Ag, Pb, and U are presented. For ions with $Z \leq 10$, the program uses experimental data and a modified version of Northcliffe's method at low energy. For ions with $Z > 10$, the nuclear and electronic stopping-power theory developed by Lindhard et al. is adjusted to fission-product range data at low energy; for intermediate energies, charge-state data developed from experimental Ar range–energy data in Al is extended to other ions and stopping media. A somewhat modified Bethe's theory used by Barkas and Berger is used here for all ions at high energy. The particle ranges presented here are merely the integral of the inverse of the stopping power and do not include the effects of high-energy multiple scattering. (auth)

28960 (UCRL-17445) INTENSITY BEATS IN RESONANCE RADIATION AND ABSORPTION DUE TO COHERENT EXCITATION OF ATOMS BY ELECTRON IMPACT. Hadeishi, Tetsuo (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 13, 1967. Contract W-7405-eng-48. 9p. (CONF-670320-2). Dep. CFSTI.

From 27th Annual Conference on Physical Electronics, Cambridge, Mass.

Intensity beats were observed in the resonance luminescence arising from the interference of electromagnetic-field quanta that are emitted from the coherently excited nondegenerate magnetic sublevels of the excited state of atoms formed by sharply pulsed, low-energy, unidirectional electron beams. In a metastable state, a similar effect was obtained by monitoring the beats in the resonance absorption. Since a large concentration of the coherently excited metastable states is required in the absorption experiment, a space–charge neutralized, high-flux unidirectional, low-energy, high-frequency modulated electron beam was used. These experiments were performed (1) to find out if the phenomena are observable and (2) to offer new methods of investigation of excited atoms. (auth)

28961 (AD-644072) COLLISIONS OF SLOW ELECTRONS WITH ATOMS. Veldre, V. Translation of [Paper MT-65-542 from International Symposium on the Properties and Use of Low-Temperature Plasma, at the XX International Congress on Theoretical and Applied Chemistry, Moscow, 1965]. 10p. (FTD-MT-65-542). CFSTI.

A review is presented of the results of the investigations on collisions between electrons and atoms which have been recently carried out in the Institute of Physics of the Academy of Sciences of the Latvian SSR. The excitation of hydrogen atoms including exchange and strong coupling between three levels, the excitation of highly excited hydrogen atoms and the ionization of a hydrogen atom are calculated. The results of calculations for the elastic scattering and excitation of atoms in alkali metals (lithium, sodium, potassium, and cesium) by electrons having the energy up to 5 eV are presented. The cross sections of a series of transitions in atoms of rare gases (neon, argon) treated by electrons have been found. (auth)

28962 EVALUATION OF SOME EFFECTIVE CROSS SECTIONS FOR SECOND-ORDER COLLISIONS OF METASTABLE He ATOMS WITH Ne ATOMS. Kokhanenko, V. V.; Prilezhaeva, N. A.; Chernenko, L. A. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 175-7 (1966). (In Russian).

Energy transmission from the atoms in a metastable state $2'S_0$ to the Ne atoms in a mixture of these two gases was studied. An intensification of the Ne spectral lines at $2P^5$, 4D, and 3S levels was observed in the glow discharge during replacement of the neon by helium. The level of $2'S_0$ He was in good resonance with the same level in Ne, therefore the intensification was the result of the second-type shocks. The calculations of the effective cross sections of the second-type shocks for the process $Ne + He^*(2'S_0) \rightarrow Ne^*(3S_4) + He^* + 0.01$ eV is $Q = 5 \times 10^{-16}$ cm^2; effective cross section for the process $Ne + He^*(2'S_0) \rightarrow Ne^*(3S_2) + He + 0.1$ eV is $Q = 3 \times 10^{-15}$ cm^2. The obtained results are in good agreement with other published data. (R.V.J.)

28963 POSITRON ANNIHILATION IN ALNICO AND $(La_{0.7}Pb_{0.3})MnO_3$. Chuang, S. Y.; Hogg, B. G. (Univ. of Manitoba, Winnipeg, Can.). Phys. Status Solidi, 20: 331-5(Mar. 1, 1967).

A study of the angular correlation of annihilation photons from positrons annihilating in alnico and single crystals of the perovskite $(La_{0.7}Pb_{0.3})MnO_3$ has been made. It is possible to account for the observed angular distributions by a simple consideration of the physical properties of the two materials. (auth)

28964 ANGULAR DEPENDENCE OF INELASTIC RESONANCE SCATTERING OF LOW-ENERGY ELECTRONS IN HELIUM. Ehrhardt, H.; Willmann, K. (Univ., Freiburg i. B.). Z. Phys., 203: 1-7(1967). (In German).

The energy dependence of the inelastic scattering of low-energy electrons into the $2\,^3S$-state of Helium was measured for different scattering angles ranging from 7 to 110°. From the measurements are derived the total angular momenta of the resonance states. The configurations of these three resonances, due to short lived negative ion states, are $2\,^2S$, $2\,^2P$, and a $2\,^2D$. Their energies are 19.95 ± 0.05, 20.45 ± 0.05 and 21.00 ± 0.05 eV. The angular dependence of the direct excitation from 21.5 eV to 24 eV varies only slightly with the energy of the colliding electrons. (auth)

28965 MEASUREMENT OF SPIN POLARIZATION OF SLOW ELECTRONS AFTER ELASTIC SCATTERING ON SOLID Hg-TARGETS. Eckstein, W. (Univ., Mainz. Univ., Munich). Z. Phys., 203: 59-65(1967). (In German).

Spin polarization $P(\Theta)$ of slow electrons elastically scattered by a solid Hg target was studied in a double-scattering experiment for electron energies between 300 and 900 eV. For the same energy range the angular dependence of the scattered intensity was measured. Maximum degree of polarization found was $P = -0.23 \pm 0.04$ ($E = 900$ eV, $\Theta = 105°$). (auth)

28966 MEASUREMENT OF THE SPIN POLARIZATION OF 900-eV ELECTRONS AFTER ELASTIC SCATTERING ON HEAVY

METAL FOILS AS A FUNCTION OF THE TARGET TEMPERATURE. Loth, R. (Univ., Mainz). Z. Phys., 203: 66-70(1967). (In German).

900-eV electrons were elastically scattered by solid targets of tungsten, platinum, and gold. The angular dependence of the scattered intensity and of spin polarization P(Θ) was investigated as a function of the target temperature. The influence of hydrogen on the scattering process by a gold target was also investigated. (auth)

28967 CONTINUUM ABSORPTION OF STELLAR ATMOSPHERES IN RELATION TO PRESSURE, TEMPERATURE, AND ELEMENT ABUNDANCE. Bode, Gerhard (Univ., Kiel). Z. Astrophys., 66: 170-4(1967). (In German).

The results of approximation calculations by the Burgess–Seaton method were tabulated for the absorption cross sections of Mg, Al, Si, and Na in stellar atmospheres in relation to pressure, temperature, and element abundance. (J.S.R.)

28968 AVERAGE ENERGY LOSS PER ION PAIR FOR HEAVY IONS AT LOW ENERGIES. Ishiwari, Ryutaro (Nara Women's Univ., Japan). J. Phys. Soc. Jap., 22: 922(Mar. 1967).

It was observed that the average energy loss per ion pair for singly charged accelerated ^{12}C ions of 40 MeV in gases is notably larger than that for ^{14}C recoils of approximately the same energy from the $^{14}N(p,n)^{14}C$ reaction. An explanation is proposed. (D.C.W.)

28969 STUDY OF THE INELASTIC INTERACTIONS BETWEEN TWO ION BEAMS. Sinda, Theodore; Manus, Claude; Guidini, Joseph (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 755-7(Mar. 6, 1967). (In French).

An apparatus and a measurement method are described. The values of the cross sections for the production of neutral particles α'_0 and of charged α'_+ particles formed from accelerated H_2^+ ions by a dissociation reaction on N_2^+ ions are given. (tr-auth)

28970 INVESTIGATION OF CONSECUTIVE ION–MOLECULE REACTIONS IN DOUBLE MASS SPECTROMETERS BY USE OF THE ION-IMPACT METHOD. Szabo, I. (Royal Inst. of Tech., Stockholm). Phys. Lett., 24A: 702-3(June 5, 1967).

The use of double mass spectrometers for studies of consecutive ion–molecule reaction as a function of energy is discussed. It is proposed that the order number of the ions can be reduced in the longitudinal type apparatus. (auth)

28971 g_J VALUES OF EXCITED STATES OF THE YTTERBIUM ATOM. Budick, B.; Snir, J. (Hebrew Univ., Jerusalem). Phys. Lett., 24A: 689-90(June 5, 1967).

The technique of optical double resonance has been used to measure g_J values in the $6s6p\ ^3P_1$ and $(4f)^{13}5d(6s)^2\ ^3P_1$ levels of the ytterbium atom. Preliminary results are $g_J = 1.492\ 80(4)$ and $g_J = 1.263\ 5(9)$ for the two levels, respectively. The measured values are used to estimate configuration interaction, relativistic and diamagnetic corrections to the g_J value of the sp configuration and to extract values for the hyperfine structure constants of the $f^{13}\ d\ ^3P_1$ level. (auth)

28972 WEAK-LINE ABSORPTION LAW IN A SEMI-INFINITE HOMOGENEOUS SCATTERING ATMOSPHERE. McClatchey, Robert A. (Jet Propulsion Lab., Pasadena, Calif.). Contract NAS 7-100. Astrophys. J., 148: L93-5(May 1967).

Chamberlain and Kuiper (1956) derived an absorption law for weak lines in a semi-infinite, well-mixed scattering atmosphere in which the scattering is assumed to be isotropic. Their result states that the equivalent widths of weak lines depend on the square root of the line intensities. Chamberlain (1965) derived the same result, but noted that it is not valid for the weakest lines when $\bar{\omega}_c \neq 1.0$. This problem is examined carefully and an attempt is made to establish the form of the weakly absorbing portion of the curve of growth in an atmosphere containing both absorbing gas and scattering particles which are well mixed and which scatter isotropically. (W.D.M.)

28973 CORRELATION EFFECTS IN ATOMS. II. ANGULAR CORRELATIONS BETWEEN ELECTRONS. Byron, F. W. Jr.; Joachain, C. J. (Univ. of California, Berkeley). Phys. Rev., 157: 1-6(May 5, 1967).

The variational–perturbation method is applied to the study of angular correlations between electrons in the helium atom. The relative merits of various basis functions for calculating the correlation energies are compared. Starting from the hydrogenic and Hartree–Fock Hamiltonians as zeroth-order approximations, detailed numerical calculations were performed on the ground state of helium. Very accurate results are obtained with a set of basis functions intermediate between the Hylleraas and the "configuration–interaction" types of trial functions. The perturbation theory of the $(1s2s)^1S_0$ and $(1s2s)^3S_1$ states is also investigated. (auth)

28974 CORRELATION EFFECTS IN ATOMS. III. FOUR-ELECTRON SYSTEMS. Byron, F. W. Jr.; Joachain, C. J. (Univ. of California, Berkeley). Phys. Rev., 157: 7-23(May 5, 1967).

The binding energy of the ground state of four-electron systems is investigated in the framework of Hartree–Fock perturbation theory. First, it is shown that the original problem can be decoupled into a series of helium-like equations describing pair correlation between electrons. Then, the variational–perturbation method is applied to each of these equations through fifth order in energy. For the correlation energies the values E_{corr} (Be) = −0.0925 atomic units (a.u.) and E_{corr} (B^+) = −0.1096 a.u. were obtained. The experimental numbers are E_{corr}^{exp} (Be) = −0.0944 a.u. and E_{corr}^{exp} (B^+) = −0.1116 a.u. (auth)

28975 OSCILLATOR STRENGTHS OF Ca II, Sr II, and Ba II. Gallagher, Alan (Joint Inst. for Lab. Astrophysics, Boulder, Calif.). Phys. Rev., 157: 24-30(May 5, 1967).

The lifetimes of the $5p^2P_{\frac{1}{2}}$ and $5p^2P_{\frac{3}{2}}$ states of Sr^+ and the $6p^2P_{\frac{1}{2}}$ and $6p^2P_{\frac{3}{2}}$ states of Ba^+ have been measured by the Hanle-effect technique with optical excitation from the ion ground state. The lifetimes of the $Mg^+\ 3p^2P_{\frac{1}{2}}$ and $Ca^+\ 4p^2P_{\frac{1}{2}}$ states were obtained by the same technique and reported previously. These Ca^+, Sr^+, and Ba^+ states each decay to a $^2D_{\frac{3}{2},\frac{5}{2}}$ doublet as well as to the ground $^2S_{\frac{1}{2}}$ state, and the branching ratios for these transitions have been measured. The ions were produced by introducing traces of the atomic vapor into an argon discharge. Consequently, the cross sections for collision depolarization of these ^2P_J states due to collisions with argon were also obtained from the measurements. The experimental results are given in tables. A discussion of the ion–atom collisional depolarization cross sections is included. (auth)

28976 ELECTRON EXCITATION FUNCTIONS OF MERCURY. Anderson, Richard J.; Lee, Edward T. P.; Lin, Chun C. (Univ. of Oklahoma, Norman). Contract AF 29(601)-6020. Phys. Rev., 157: 31-40(May 5, 1967).

Absolute excitation functions of some 40 transitions of the mercury atom have been measured. As in the case of helium, the excitation functions of the singlet states have the common feature of a broad maximum around 30 eV, whereas the triplet states show the characteristic sharp peaks at lower voltages. The excitation functions of the lower states exhibit fine structure near the threshold, which may be attributed to cascade from the states of higher energies. The cascading effect has been examined for the excitation of the $7\ ^1S_0$, $7\ ^3S_1$, $7\ ^3P_2$, $6\ ^3D_3$, and $6\ ^3D_2$ states. At 15 eV the cascade corrections are small for $7\ ^3P_2$, $6\ ^3D_3$, and $6\ ^3D_2$, but amount to approximately 42% for $7\ ^1S_0$. The major source of population of the $7\ ^3S_1$ state is found to be cascade transitions from the $7\ ^3P_2$ state rather than direct excitation. Direct-excitation cross sections of the $7\ ^1S_0$, $6\ ^3D_3$, $6\ ^3D_2$, and $7\ ^3P_2$ states at 15 eV have been determined and the results are compared with the theoretical calculations. (auth)

28977 CALCULATIONS ON THE SCATTERING OF ELECTRONS BY ATOMIC SYSTEMS WITH CONFIGURATIONS $2p^q$. Smith, Kenneth (Royal Holloway Coll., Englefield Green, Eng.); Henry, R. J. W.; Burke, P. G. Contract AF29(601)-6801. Phys. Rev., 157: 51-68(May 5, 1967).

The continuum Hartree–Fock equations that describe the radial motion of an electron incident on carbon, nitrogen, and oxygen atoms, and on singly ionized oxygen, all in the ground-state configuration, have been solved. The resulting elastic and inelastic cross sections among the three ground-state terms of the atoms are presented and compared with previous calculations and experiment. The autoionization levels in atomic oxygen are calculated and found to be in good agreement with the experimental determinations of the corresponding atomic-oxygen absorption-line series. (auth)

28978 COLLISIONAL DEPOLARIZATION OF THE Rb 5p AND Cs 6p DOUBLETS. Gallagher, Alan (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 157: 68-72(May 5, 1967).

The Hanle-effect technique was used to measure the cross sections for collisional depolarization of the $Rb^2P_{\frac{1}{2},\frac{3}{2}}$ and $Cs^2P_{\frac{3}{2}}$ states by inert-gas collisions. The natural lifetimes of these states were also obtained from the measurements. The $^2P_{\frac{3}{2}}$-state depolarization cross sections are much smaller than any previously reported for $L \neq 0$ states. This results from a strong selection rule governing nonresonant collisions. This selection rule is derived and its effect on $J = \frac{1}{2}$-state depolarization is demonstrated. A relationship between the reported cross sections and sensitized fluorescence cross sections is noted. (auth)

28979 IMPROVED QUANTUM THEORY OF MANY-ELECTRON SYSTEMS. I. CONSTRUCTION OF EIGENFUNCTIONS OF S^2 WHICH SATISFY PAULI'S PRINCIPLE. Goddard III,

William A. (California Inst. of Tech., Pasadena). Phys. Rev., 157: 73-80(May 5, 1967).

A general method of obtaining many-electron wave functions that are eigenfunctions of $\hat{S}^2$ and that also satisfy Pauli's principle is developed. This method is based on the properties of the irreducible units of the group algebra of the symmetric group. This method is used to find expansions of the exact wave function that will, in succeeding articles, form the basis of a powerful method of obtaining accurate and quite useful many-electron wave functions for atoms, molecules, and solids. (auth)

28980 IMPROVED QUANTUM THEORY OF MANY-ELECTRON SYSTEMS. II. THE BASIC METHOD. Goddard III, William A. (California Inst. of Tech., Pasadena). Phys. Rev., 157: 81-93(May 5, 1967).

A general method of obtaining accurate and useful many-electron wave functions for atoms and molecules is developed. The method involves the proper optimization of a many-electron function that is an eigen-function of total spin and that satisfies Pauli's principle. The procedure is somewhat similar to that in which one obtains the Hartree–Fock wave function by properly optimizing a Slater determinant. There are three key features of the new method: (1) The wave function remains accurate as the nuclei configuration is changed from the equilibrium configuration to that of the dissociated molecule; (2) the many-electron wave function can be interpreted in an independent-particle scheme; (3) the independent-particle states are no longer always required to be symmetry functions for the spatial symmetry group as in the Hartree–Fock method. In addition, the energy calculated using the new method is always lower than the Hartree–Fock energy, and the method is applicable to states of any total spin and number of particles. Calculations using this method are reported for the H_2 and LiH molecules. (auth)

28981 MAGNETIC HYPERFINE STRUCTURE OF LITHIUM. Goddard III, William A. (California Inst. of Tech., Pasadena). Phys. Rev., 157: 93-6(May 5, 1967).

For the first time a spin-polarized extended Hartree–Fock calculation on a three-electron system, Li, is reported. The calculations are discussed with primary emphasis on the hyperfine splitting spectrum, which is determined by the spin density at the nucleus, $Q(0) = \langle\psi|\Sigma_i \hat{s}_z(i)\delta(r_i)|\psi\rangle/S$. Q(0) for the ground state is calculated to be 0.2403, as compared with the experimental value of 0.2313. (auth)

28982 MEASUREMENT OF CHARGE-TRANSFER CROSS SECTIONS FOR 0.25- TO 2.5-MeV PROTONS AND HYDROGEN ATOMS INCIDENT UPON HYDROGEN AND HELIUM GASES. Williams, J. F. (Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales). Phys. Rev., 157: 97-100(May 5, 1967).

Measurements of the single- and double-electron-capture cross section for protons, σ_{10} and $\sigma_{1,-1}$, respectively, and the single-electron-loss cross section for hydrogen atoms σ_{01} within the energy range 0.25 to 2.5 MeV for molecular-hydrogen and atomic-helium target gases have been made by the method of observing the rate of growth with target-gas number density of the fast-collision products from an originally pure primary beam. The present values of σ_{10} and σ_{01} agree within 10% with the data of Barnett and Reynolds below 1 MeV and confirm the extrapolation of their data, which passes through the single measurements of σ_{10} and σ_{01} for 12.9- and 21-MeV deuterons and 20-MeV deuterium atoms by Berkner, except for σ_{10} in He where the extrapolation of the present data passes below the values of Berkner. The experimental values of σ_{01} agree with calculated values of σ_{01} derived from the Born and free-collision approximations within the experimental uncertainty of ±10%. The values of $\sigma_{1,-1}$ in molecular hydrogen decrease from 5.1×10^{-25} cm²/molecule at 0.4 MeV to 1.6×10^{-28} cm²/molecule at 1 MeV with an experimental uncertainty of up to 60%. These values are lower than the first-Born-approximation calculations by Mittleman. (auth)

28983 SYMMETRIC-RESONANCE CHARGE TRANSFER IN Ar FROM 0.1 TO 20 eV USING MERGING BEAMS. Neynaber, R. H.; Trujillo, S. M.; Rothe, Erhard W. (General Dynamics/Convair, San Diego, Calif.). Phys. Rev., 157: 101-2(May 5, 1967).

The absolute cross section for $Ar^+ + Ar \rightarrow Ar + Ar^+$ at an interaction energy W of 0.3 eV has been measured using a previously described merging-beams technique. A modification of this method has also been employed to measure relative cross sections for the same process in a range of W from 0.1 to 20 eV. The results are in agreement with the theoretical prediction of Rapp and Francis. (auth)

28984 USE OF INELASTIC ELECTRON SCATTERING DATA TO OBTAIN ACCURATE BORN CROSS SECTIONS FOR ATOM–ATOM AND OTHER HEAVY-PARTICLE COLLISIONS. I. PROTON EXCITATION OF THE SCHUMANN–RUNGE CONTINUUM IN O_2. Green, Thomas A. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 157: 103-6(May 5, 1967).

It is pointed out that the accurate generalized oscillator strengths obtained by Lassettre and his co-workers from inelastic scattering experiments make it possible to evaluate the first-Born-approximation cross sections for certain ion–atom, atom–molecule, etc., collisions with greater accuracy than can usually be obtained if the generalized oscillator strengths are calculated from the electronic wave functions of the colliding particles. The idea is illustrated by a comparison of the experimental generalized oscillator strength for the excitation of the Schumann–Runge transition in O_2 with a theoretical generalized oscillator strength based on Kotani's wave functions for O_2, and by the calculation of the Born total cross section for proton excitation of this transition. The cross section is compared with that obtained by Breene via an impact-parameter calculation. (auth)

28985 EXCITATION OF HYDROGEN MOLECULE BY ELECTRON IMPACT. III. SINGLET–TRIPLET EXCITATIONS. Khare, S. P. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 157: 107-12(May 5, 1967).

One-center wave functions of Huzinaga along with the Ochkur approximation have been employed to investigate the exchange excitation of the hydrogen molecule by electron impact from the ground electronic state X ($1s\sigma\ ^1\Sigma_g^+$) to the triplet a($2s\sigma\ ^3\Sigma_g^+$), b($2p\sigma\ ^3\Sigma_u^+$), and c($2p\pi\ ^3\Pi_u$) electronic states. Since the lowest triplet state b($^3\Sigma_u^+$) is a repulsive state and the intercombination of the triplet and the singlet states are optically forbidden, the singlet–triplet excitations give rise to the dissociation of the hydrogen molecule into two hydrogen atoms. The shape of the theoretical curve for the dissociation cross section is in general accord with the experimental data of Corrigan. Theoretical efficiencies of the dissociation of the hydrogen molecule by electron impact and of the emission of the continuous radiation due to $a(^3\Sigma_g^+) \rightarrow b(^3\Sigma_u^+)$ transitions have also been computed and are compared with the available experimental data. (auth)

28986 METASTABLE ATOMS AND MOLECULES. I. METASTABLE STATES PRODUCED IN CHARGE-EXCHANGE PROCESSES. Varney, R. N. (Lockheed Research Labs., Palo Alto, Calif.). Phys. Rev., 157: 113-15(May 5, 1967).

A beam of ions of energy between 25 and 360 eV was formed and permitted to pass through the parent gas at pressures between 5 and 100 μ. The beam then emerged into a highly evacuated space (2 to 9×10^{-5} Torr) and impinged on a target of Mo. When the ions of the beam were deflected and prevented from reaching the target, a target current of secondary electrons or ions to the housing surrounding the target disclosed that neutral particles, formed by charge exchange, were reaching the target, and that these neutrals were excited with long lives compared with a microsecond. The behavior was tested in H_2, N_2, Ne, and Ar, all of which were found to contain excited states in the neutral beam. A new variant of the charge–exchange process thus appears to be occurring in the production of excited neutrals. The essential technique is to cause the charge–changing collisions to occur directly in the source. It is believed that different mechanisms are active in different gases, but that collisions between ions and excited atoms or molecules occur commonly under the experimental conditions existing in this study, where very short times exist between electron–atom collisions and ion–atom exchange collisions. (auth)

28987 METASTABLE ATOMS AND MOLECULES. II. INTERACTIONS OF METASTABLE ATOMS AND MOLECULES OF Ar, H_2, AND N_2 WITH METAL TARGETS. Varney, R. N. (Lockheed Research Lab., Palo Alto, Calif.). Phys. Rev., 157: 116-20(May 5, 1967).

Neutral atom or molecule beams with kinetic energies ranging from 25 to 360 eV have been allowed to strike a molybdenum target. With argon, the observations disclosed that surface ionization occurred with ejection of low-energy positive ions, and that secondary electron emission occurred. With hydrogen, no surface ionization was observed, but there was secondary electron emission and there was strong photon emission from the target with subsequent tertiary electron emission. The photon emission was identified roughly to be in the energy range of Lyman α radiation. With nitrogen, there was no surface ionization, but there was considerable ejection of negative ions identified as CN^- with kinetic energies up to the range of 20 eV. The negative ions could not be eliminated by flashing the target. A weak secondary and tertiary electron emission was also observable. (auth)

28988 ORTHOGONAL WAVES ON ELECTRON BEAMS. Zotter, Bruno W. (Army Electronics Command, Fort Mon-

mouth, N. J.). IEEE (Inst. Elec. Electron Eng.) Trans. Electron. Devices, ED-13: 925-9(Dec. 1966).

Besides the well-known space-charge waves, which are purely longitudinal oscillations, an electron beam can also propagate electromechanical waves with transverse velocity components. Typical examples are the cyclotron and synchronous waves which have the azimuthal mode number n = 1, i.e., their amplitudes go through one full cycle around the circumference of the beam. The propagation of slow electrokinetic waves on finite electron beams which fill a conducting tunnel is discussed for modes of axial symmetry. In addition to the familiar space-charge modes, a pair of modes exists which are related to the vortex frequency ($\omega_v = \omega_c - 2\Theta_0$). The finite magnetic field introduces a coupling between these modes. A set of 4 orthogonal modes can be derived by the use of matrix transformations, thus eliminating the necessity of solving a complicated characteristic equation. For infinitely high magnetic fields, the 2 additional modes disappear and the 4 modes reduce to the fast and slow space-charge waves. (BBB)

28989 DYNAMIC BEHAVIOR OF A LONG THIN ELECTRON BEAM BEYOND CRITICAL PERVEANCE. Twombly, J. C. (Univ. of Colorado, Boulder). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron. Devices, ED-13: 934-41(Dec. 1966).

A discrete mathematical model was derived for the case of a thin infinite planar electron beam injected with symmetry between 2 parallel semi-infinite plane conductors separated by a distance d and joined by a third equipotential plane through which the beam is injected. The computer model is first shown correctly to reproduce the calculable space-asymptotic beam velocity for subcritical perveance and is then employed to simulate the dynamic behavior accompanying operation beyond critical perveance. Rejection of a fraction of the injected charge is shown to be an essential feature of this mode of operation, and the oscillating potential minimum is seen to exist at a distance less than d from the injection plane. A relatively simple modification of the model portrays the unstable behavior of a terminated beam only 6d long. Longitudinal potential profiles for this terminated beam are plotted at selected points in time. Oscillation frequency at a given supercritical perveance is noted to be an inverse function of transit time defined with respect to any chosen stable perveance and beam length in units of d. (BBB)

28990 EQUIVALENCE OF PERIODIC MAGNETIC FIELD TO UNIFORM MAGNETIC FIELD IN ELECTRON BEAM FOCUSING. Ura, K.; Terada, M. (Osaka Univ.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron. Devices, ED-13: 930-4(Dec. 1966).

The general solution of the electron trajectory equation in a periodic magnetic field was derived in the form of series expansion, assuming laminar electron flow and small perturbation. It was concluded that if the cathode is not very heavily immersed in a magnetic field, beam focusing by a periodic magnetic field would be almost equivalent to that by a uniform magnetic field except near the unstable region. Under these restrictions, each focusing system would give almost the same beam ripple (in magnitude and phase) under the same injection conditions into the focusing system. It was also found that the first stable region of beam perturbation in the periodic magnetic field becomes narrower as the flux threading the cathode increases or the period of the magnetic field decreases, as far as linearization of the path equation is possible. (BBB)

28991 ANISOTROPY OF THE ANGULAR DISTRIBUTION AND STRUCTURE OF THE ENERGY DISTRIBUTION OF IONS SCATTERED BY THE SURFACE OF A SINGLE CRYSTAL. Aliev, A. A.; Arifov, U. A. (Physical-Technical Inst., Tashkent). Dokl. Akad. Nauk SSSR, 172: 65-8(Jan. 1, 1967). (In Russian).

To check on earlier calculations by the authors, an investigation was made of the angular dependence of the coefficient of secondary ion emission and the energy distribution of secondary alkali ions scattered by single crystals of W and Mo. The apparatus was modified to increase the resolution. The results show that the spectrum contains, besides the peak of ions singly scattered by individual atoms of the target, additional peaks in the high energy region corresponding to doubly scattered ions by different crystallographic planes. Similar secondary peaks are also observed for the energy distributions of the secondary ions. The ion-scattering coefficient is higher for single crystals than for polycrystals at all scattering angles, and shows a faster growth with increasing angle. It has a minimum near 45° and also decreases with increasing ion energy. The coefficient variation is interpreted from the point of view of the contributions made by various crystallographic planes. (ATD)

28992 MULTIPLE ELECTRON SCATTERING IN THIN FOILS. Paul, Helmut; Tatzber, Werner (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). Acta Phys. Austr., 25: 36-54(Apr. 1967).

A Monte Carlo program was used to calculate angular distributions of electrons backscattered from or transmitted through thin foils, neglecting energy loss. The single scattering cross sections were taken from the review article by Motz et al. Electron sources were assumed monodirectional or isotropic. The following electron energies (foil materials) were considered: 50, 100, 200, keV (Al) and 100 keV (N and Ag). For a monodirectional source and normal incidence, the angular distribution of transmitted electrons is found to agree with Molières theory, and an attempt is made to compare the backscattering coefficient to measured transmission values. For oblique incidence, electrons appear to be "reflected" at the surface, and the distributions are similar to those measured by Kanter. For an isotropic source, (incident directions from 0° to 90°, where 0° is the normal on the foil) backscattering reaches a maximum near 93°. This maximum is essentially independent of Z and energy; it is due to multiple scattering of grazing incident electrons in the uppermost layers; its saturation value is reached at small foil thickness. At large angles, on the other hand, backscattering varies with Z and energy roughly like the single scattering cross section; it increases about linearly with foil thickness; it agrees roughly with the backscattering coefficients measured in a beta spectrometer by Subba Rao and by Riehs, but not with those measured by Quivy. If a foil is placed on top of an isotropic source, the transmitted electrons are no more isotropic. In the foil direction (90°), the transmission is very small, but at smaller angles (60 to 80°) it reaches an apparent maximum of 110% due to scattering-in. (auth)

28993 FLUORESCENT RESPONSE OF NaI(Tl) AND CsI(Tl) CRYSTALS TO HEAVY IONS OF ENERGIES 1 TO 300 keV. Cano, Gilbert L.; Lockwood, Grant J. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 157: 677-84(May 15, 1967).

The relative fluorescence output of freshly cleaved NaI(Tl) single crystals under bombardment with ions of mass from 1 to 133 amu was determined as a function of particle kinetic energy, in keV, as follows: H and D from 1 to 100; He from 10 to 100; Li from 20 to 100; C from 10 to 200; N from 10 to 200; O, F, and Na from 20 to 200; Ne from 15 to 200; Al from 30 to 100; Ar and Xe from 30 to 200; I from 50 to 100; Kr from 60 to 200; and Cs from 50 to 200. Except for H, D, Ne, and Na ions, the pulse-height-versus-energy relation for each different-mass ion shows two distinct linear regions. The change in slope for ions of mass less than that of Na is negative; for ions of mass greater than that of Na the change in slope is positive. In the energy range used, the slope of the pulse-height-versus-energy relation decreases as the incident ion mass is increased. In CsI(Tl) the pulse-height-versus-energy relation is linear for all the different ions used. The ratio of pulse height from NaI(Tl) to that from CsI(Tl) for a given mass and energy ion was typically 2.3. However, because of the slope change for NaI(Tl) the ratio varied from 2.0 to 2.5. Except for a few unexplained instances, the resolution by NaI(Tl) is approximately proportional to $E^{-\frac{1}{2}}$. A theoretical calculation based on a model of energy transfer by the incident particles to the principal constituents of the crystal lattice is presented. In this model, the energy transfer is divided into light-producing atom-electron interactions and atom-atom interactions in which negligible light production occurs. The model can explain logically the decreasing scintillation efficiency at a given energy as the incident particle mass is increased. Theories of Bohr and of Lindhard, Scharff, and Schiott are coupled in the development of the model used. Universal pulse-height-versus-energy relations result. (auth)

28994 COINCIDENCE EXPERIMENTS FOR INVESTIGATION OF ENERGY TRANSFER IN COLLISIONS OF LOW-ENERGY ELECTRONS WITH MOLECULES. Ehrhardt, H.; Linder, F. (Univ., Freiburg i. B.). Z. Naturforsch., 22a: 444-53(Apr. 1967). (In German).

Scattering experiments of 70-eV electrons from methane and n-heptane are described. The results, namely energy-loss spectra, and the energy and angular distributions of the ejected electrons of these molecules are compared with those of argon. A coincidence technique is used to determine the energy distributions of the probability for formation of the molecular ions. By subtraction of the distributions from the total energy-loss spectra, the distributions of the superexcited states are obtained. In the case of n-heptane, superexcited states are found up to 20 eV above the first ionization potential. (auth)

28995 STUDY OF INELASTIC SCATTERING BETWEEN CO MOLECULES AND PROTONS BETWEEN 30 AND 600 keV. Poulizac, M. C.; Desesquelles, J.; Dufay, M. (Faculte des Sciences, Lyon). Ann. Astrophys., 30: 301-13(Mar.-Apr. 1967). (In French).

The interactions of a proton beam with a carbon monoxide target were investigated in the energy range 30 to 600 keV. The total cross sections for ionization and charge transfer were determined

using an electrostatic collector for slow ions and secondary electrons and by measuring the attenuation of the proton beam. The spectrometric study of the gas luminescence indicates the presence, in the spectrum, of the first negative band system, of the comet tail system, and of the Baldet–Johnson CO^+ system. The fourth positive system, the Angström system, and the Herzberg system are also excited by primary collisions, while the third positive system is due to a secondary process. The dissociation of CO is weak as shown by the intensity of some C I, C II, O I lines. The cross sections for excitation of the first vibrational levels of the $B^2\Sigma$ and $A^2\Pi$ states were measured. The relative intensities of the different bands of the first negative and the comet tail CO^+ systems correspond to high vibrational temperatures. (auth)

28996 EXCITATION OF PULSATIONS IN THE OUTPUT OF A MOLECULAR BEAM OSCILLATOR. Basov, N. G.; Morozov, V. N.; Oraevskii, A. N. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 335-8(Feb. 1967). (In Russian).

The excitation of pulsations in the output of a molecular beam oscillator is discussed by modulation of the current of active particles entering the cavity. The calculations are based on differential equations for the electric field in the resonator, the average polarization of the active particles, and the initial density of active particles. From these there is derived a third-order nonlinear differential equation for the radiated power in the presence of modulation of the active particle flux. The periodic solutions of this equation are discussed. It is shown that undamped pulsations of the output appear when the percent modulation of the active particle flux exceeds a critical value and that increase of the modulation of the active particle flux above the critical value results in a shift in the phase but no change in the depth of the output modulation. Illustrative numerical computations show that output pulses with a pulse duration of about 10^{-4} sec and a repetition rate of 2 kHz can be obtained with an ammonia beam oscillator having a cavity Q factor of 3×10^4 by modulating the flux of active particles to a depth of 10%. (ATD)

28997 ION BEAMS AND MATERIALS RESEARCH. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Atom, No. 125, 59-62(Mar. 1967).

The interaction of ion beams with solids has provided a fruitful field for research on atomic collision phenomena. Progress has recently been made in the field of ion implantation—forcing impurity atoms into a solid by ion bombardment. Studies at AERE, Harwell over the past 10 years are described in this paper, directed at a variety of materials problems. These include the implanting of inert gas atoms into solids, leading to a better understanding of the formation and movement of gas bubbles in reactor materials—also studies on crystal structure, and a variety of other phenomena such as precipitation in alloys and the doping of semiconductors. Headings of the paper are as follows—Atomic collision phenomena (radiation damage studies, channeling and proton scattering microscopy)—Ion implantation (gas bubbles in solids, precipitation in alloys, doping of semiconductors). (UK)

28998 TRANSITION PROBABILITIES OF THE HYDROGEN ATOM FROM NONCOMPACT DYNAMICAL GROUPS. Barut, A. O.; Kleinert, Hagen (Univ. of Colorado, Boulder). Phys. Rev., 156: 1541-5(Apr. 25, 1967).

In order to describe electromagnetic dipole transitions of the H atom within the framework of dynamical groups, an explicit irreducible representation of the Lie algebra O (4,2) was found on the space of boundstate wave functions. This representation remains irreducible when restricting to the subalgebra O (4,1). The transformation properties of the dipole operator in O (4,2) are specified. The description becomes particularly simple by the introduction of a one-parameter family of representations of O (4,2). Finally, position representations of the generators of O (4,2) are given. (auth)

28999 SLOWING DOWN CAPACITY OF NICKEL FOR PROTONS AND He_4^+ IONS IN THE ENERGY RANGE FROM 20 TO 95 keV. Bogdanov, G. F.; Kabaev, V. P.; Lebedev, F. V.; Novikov, G. M. At. Energ. (USSR), 22: 126-7(Feb. 1967). (In Russian).

The value of the specific energy loss of protons at 20 to 95 keV and He_4^+ at 30 to 90 keV in Ni foils was measured. The results are tabulated and are graphed as a function of the energy of the incident particle. The dependence of the energy loss on the energy agrees with the results of previous studies. (J.S.R.)

29000 POTENTIALS OF URANIUM ATOMS AND CALCULATION OF THE IONIZATION ENERGY. Kudrin, L. P.; Mazeev, M. Ya. At. Energ. (USSR), 22: 83-5(Feb. 1967). (In Russian).

On the basis of the statistical model and with consideration of the exchange interactions and correlation of electrons, the atomic and ionic potentials of U were calculated. It is shown that calculation of the electron correlation is essential for calculation of the integral atomic characteristics. By means of the curves obtained for atomic and ionic potentials the ionization energies I_1, I_2, and I_3 were calculated. The theoretical results are compared with the experimental data. (tr-auth)

29001 CHARGE TRANSFER IN THE CLASSICAL BINARY-ENCOUNTER APPROXIMATION. Garcia, J. D.; Gerjuoy, E. (Univ. of Pittsburgh). Phys. Rev. Lett., 18: 944-6(May 29, 1967).

Cross sections were calculated for the reactions $H^+ + H \rightarrow H(2s) + H^+$, $H^+ + H_2 \rightarrow H(2s) + H_2^+$, and $H^+ + He \rightarrow H(2s) + He^+$ using the expression from the Gryzinski model for classical binary encounter theory. (M.O.W.)

29002 ANALYTICAL FORMULAS FOR THE SCATTERING AMPLITUDE FOR IONIZATION AND EXCITATION BY ELECTRON IMPACT. Pecul, K. (Inst. of Nuclear Research, Warsaw, Univ. of Warsaw). Acta Phys. Pol., 31: 803-6(May 1967).

Analytical formulas for the scattering amplitude for ionization and excitation of an arbitrary bound state of an atom by electron impact are given. The scattering amplitude is expressed by derivatives of a simple generating function. The formulas for excitation are special cases of those for ionization. (auth)

29003 ATOMIC SCATTERING FROM A PERFECT CRYSTAL. Howsmon, A. J. (State Univ. of New York, Buffalo). pp 67-82 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

Using the formulation described in a previous paper the elastic differential cross section for the scattering of an atom from a perfect crystal is calculated. The model treats the incident atom as a quantum mechanical particle and the crystal as a three-dimensional orderly array of atoms having thermal motion. The interaction is assumed to be of the form of a Morse potential acting between the incident atom and each atom of the array. The resulting differential cross section describes the scattering in terms of a diffraction phenomenon. The results are shown to compare favorably with experiment in a qualitative manner on variation of the significant parameters of the gas-crystal system. (auth)

29004 CALCULATIONS OF THE INTERACTIONS OF DIATOMIC MOLECULES WITH SOLID SURFACES. Oman, R. A. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). pp 83-100 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

Three-dimensional classical interactions of homonuclear diatomic gas molecules with fcc solid surfaces were calculated by digital computer. The results are compared to matched monatomic interactions previously reported, and to a phenomenological model which gives algebraic expressions for the energy exchanges. Diatomic results indicate an important reduction in energy and tangential momentum transmitted to the lattice, but a slight increase in gas exit energy over the monatomic cases. Diatomic particles experience significantly less lateral scattering than do monatomic. Vibrational energy changes are small, except at high energy, and rotational energy change varies linearly with incident translational energy. (auth)

29005 THERMAL ACCOMMODATION OF RARE GASES ON CLEAN METAL SURFACES: COMPARISON OF A SIMPLIFIED CLASSICAL LATTICE THEORY WITH EXPERIMENTS. Trilling, L. (Massachusetts Inst. of Tech., Cambridge). pp 139-54 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The energy interaction of an inert light gas molecule with a cold linear nearest neighbor lattice is computed, as a function of three dimensionless parameters: solid-gas atomic mass ratio, solid-bond-gas thermal energy ratio, and interaction potential well depth-gas thermal energy ratio. The results appear self-consistent and agree with a wide range of measured results for a reasonable range of basic physical parameters. (auth)

29006 DIFFUSION THEORY IN A GRAVITATIONAL FIELD. Ziering, S.; Skeinblatt, M. (Space Sciences, Inc., Waltham, Mass.). pp 325-44 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The effect on diffusion phenomena of increasing mean free path with altitude in the upper regions of the atmosphere is considered. It is postulated for intermediate and large mean free paths (with respect to the scale height), that the gravitational field will have a significant influence on the particle motion within a few mean free paths. The relative effect of collision mechanisms versus gravita-

tional field is then of concern. It is evident that the standard barometric formula for the density and for the pressure will not suffice. An extension of the Chapman–Enskog theory for diffusion processes into rarefied gas domains was presented in a recent paper by the authors. In the present study the effects of the gravitational field are incorporated into the respective Boltzmann equations. The zeroth order solution for the distribution function yields the customary barometric formula (i.e., $n = n_0 \exp[-mgx/kT]$). A four-component approximation, in which the respective densities and flow velocities are retained, and their corresponding moment equations are solved, yields an interesting analytic solution. This is the approximation, which in the absence of the gravitational field, yields the standard Chapman–Enskog solution for diffusion phenomena. For the next higher approximation, namely the eight-component solution (retaining densities, flow velocities, temperatures and heat flow parameters) the solution (of the eight coupled equations) can be reduced to a complex second order differential equation in any one of the variables. It is then possible to solve this equation by numerical techniques. In this approximation a general expansion solution, as well as a solution further approximating the collision effects, are discussed. In an appendix the simpler equations for the case of self-diffusion in a gravitational field are sketched out. All solutions are explicit functions of the intermolecular interaction model. (auth)

29007 NEW CONCEPT IN CHARGE EXCHANGE MOLECULAR BEAMS. Hushfar, F. (Air Force Cambridge Research Labs., Bedford, Mass.); Rogers, J. W.; Webb, D. pp 1427-42 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The application of a new concept in the charge exchange method for production of molecular beams is presented. A conventional plasma was produced by an rf discharge, and the motion of the ions and electrons controlled by the use of a curved longitudinal magnetic field. An ion beam whose space charge is partially neutralized by the presence of plasma electrons was produced. Ion beams of 0.6-cm diameter and up to 7 μA were recorded, and charge-exchange neutralization of 50% was achieved. A thermal detector was used to confirm the existence of a molecular beam with an average energy of 1 to 2 eV and intensity 10^{13} to 10^{14} particles/cm^2/sec without any acceleration voltage applied. (auth)

29008 A MOLECULAR BEAM APPARATUS FOR THE 0 TO 50 eV REGION. Politiek, J.; Rol, P. K.; Los, J.; Onderdelinden, D.; Schipper, J. J. M. (FOM Inst. for Atomic and Molecular Physics, Amsterdam). pp 1443-54 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

A molecular beam apparatus has been built which uses the phenomenon of cathode sputtering for the production of an atom beam with energies in the range from 0 to 50 eV. This apparatus was designed for the measurement of total collision cross sections, but it can also be used for the determination of the velocity distribution of sputtered particles. A potassium target is bombarded by a 6-keV Ar^+ ion beam, which is produced by a unoplasmatron source. By means of two slits the sputtered atoms are collimated, giving a beam of atoms in the eV range. A 6% resolution slotted-disk velocity selector is placed between the two collimating slits. The neutral atoms are detected by a conventional surface ionization platinum–tungsten wire. With this apparatus the velocity distribution of the sputtered atoms was measured up to a velocity of 9400 m/sec, corresponding to an energy of 16.5 eV for potassium. The high-velocity part of the distribution may be used to determine the focusing energy in potassium. A plot of the velocity distribution n(v) versus v^{-1}, showing a straight line, is extrapolated to zero intensity. The threshold velocity found in this way is very closely related to the focusing energy. From this experiment the focusing energy in potassium is found to be 43 ± 10 eV. (auth)

29009 TIME-OF-FLIGHT VELOCITY ANALYSER USING METASTABLE MOLECULES. French, J. B.; Locke, J. W. (Univ. of Toronto). pp 1461-8 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

A new technique is described for measuring the velocity distribution function at a point in a rarefied gas flow based on the time-of-flight of metastable molecules. Only an electron gun and an electron multiplier need be introduced into the vacuum chamber; there are no moving parts of any kind. The technique can, in principle, be applied to many gases. The technique is shown to work well in a near room temperature effusive flow in helium. (auth)

29010 EFFECTIVE SPATIAL RESOLUTION OF THE ELECTRON BEAM FLUORESCENCE PROBE IN HELIUM. Maguire, B. L. (General Electric Co., Philadelphia). pp 1497-1518 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

An experimental study of the spatial distribution of the fluorescence observed when a moderately energetic (20-keV) beam of electrons is used to excite helium is described. Both the total emission intensity and the spatial distribution of the fluorescence were measured for the various classes of transitions in helium. A quantitative measurement of the effect of the absorption of resonance radiation on the spread of 5016 Å light is presented as a function of helium pressure. (auth)

29011 GROSS FAILURE OF THE CONVENTIONAL ADIABATIC CRITERION; STRUCTURE AND COHERENCE IN THE LOW-ENERGY EXCITATION OF HELIUM ATOMS BY HELIUM IONS. Dworetsky, S.; Novick, R.; Smith, W. W.; Tolk, N. (Columbia Univ., New York). Phys. Rev. Lett., 18: 939-41 (May 29, 1967).

Further evidence for the conclusion that ion–atom and ion–molecule collisions can be highly effective in producing optical excitation is presented for the case of excitation of helium atoms by He^+ ions. (M.H.R.)

29012 BREAKDOWN OF SYMMETRY AND GAPLESS SPECTRUM IN MANY-BOSON SYSTEMS. Coniglio, A. (Istituto Nazionale di Fisica Nucleare, Naples); Marinaro, M. Nuovo Cim. (10), 48B: 262-92(Apr. 11, 1967).

A method of approximation was developed to calculate the excitation spectrum and the ground-state energy of an infinite system of interacting bosons at temperature T = 0. It is shown that this method is suitable for describing systems of interacting bosons which present condensation in single-particle states or in two-particle state. In both cases the excitation spectrum is gapless and the current is conserved. (auth)

29013 EXCHANGE CONTRIBUTION IN THE SCATTERING OF ELECTRONS BY ATOMS AND POSITIVE IONS. Bely, O. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Contract DA-31-124-ARO-D-139. Nuovo Cim. (10), 49B: 66-86(May 11, 1967).

The Ochkur approximation (1963) for the exchange scattering amplitude is discussed as well as the modification proposed by Rudge (1965). While Ochkur's approximation cannot be obtained from a variational expression, the expression given by Rudge does not satisfy the detailed balance principle. Two approximations are proposed for the exchange contribution to the T matrix occurring in the scattering of electrons by neutral atoms and positive ions. The first approximation (E I) does not take account of the flux conservation but satisfies the principle of the detailed balance. The second one (E II) satisfies this principle and also ensures the flux conservation. Both approximations are then applied to the calculation of the cross-section $Q(^3P \rightarrow {}^1D)$ in the ground configuration of the silicon and carbon series. Comparison with previous calculations is fairly satisfactory. It appears that for the highly ionized ions the main contribution is not due to the angular momentum l = 1 but to the first four angular momenta. Finally, the algebraic coefficients entering in the calculation of the exchange part of the R matrix are given in the case of one- and two-electron atoms and ions as well as for the transitions occurring between the l^n configurations. (auth)

29014 POTENTIALS OCCURRING IN THE EXCITATION OF HIGHLY IONIZED IONS BY ELECTRON IMPACTS. Bely, O. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Contract DA-31-124-ARO-D-139. Nuovo Cim. (10), 49B: 87-102 (May 11, 1967).

The scattering of electrons by ions is considered. The ion is supposed to be in a state of intermediate coupling. Allowance for the interaction of configuration is also made. Neglecting the possibility of exchange between the incoming electron and the electron of the ion, the problem is formulated in terms of the partial-wave theory. The potentials occurring in the coupled operations derived are found to be a linear combination of the potentials occurring in the usual scattering theory of electrons by ions. The final expressions for these potentials are derived in fairly simple forms and are given for four general kinds of transitions which generally occur. In the particular case in which only the interaction of configurations is taken into account, a very simple relation is given which relates the cross sections $Q(\alpha LSJ \rightarrow \alpha' L'SJ')$ to the cross sections $Q(\alpha LS \rightarrow \alpha' L'S)$, both cross sections being computed in the Coulomb–Born approximation. An example is given which shows the role of the intermediate coupling in the computation of the fine-structure cross sections. (auth)

29015 GENERALIZED OSCILLATOR STRENGTHS AND ABSOLUTE-ZERO-ANGLE CROSS SECTIONS FOR INELASTIC ELECTRON–HELIUM COLLISIONS. Heideman, H. G. M.; Vriens, L. (Univ. of Utrecht). J. Chem. Phys., 46: 2911-18(Apr. 15, 1967).

Absolute-zero-angle cross sections for excitation of helium to the 2^1P level have been calculated with the Bethe theory, using Lassettre's generalized oscillator strengths (for $1^1S \rightarrow 2^1P$) normalized to the optical oscillator strength of Schiff and Pekeris. Absolute-zero-angle cross sections (in the 25- to 1000-eV energy region) for transitions to several other helium states were obtained, using (a) the calculated cross section for excitation to the 2^1P level and (b) already measured cross-section ratios (obtained from energy-loss spectra) or known optical oscillator strengths. These cross sections, which are not very accurate for small incident electron energies because of application of the Bethe theory, have been to determine generalized oscillator strengths for the transitions $1^1S \rightarrow 3^1P$, 4^1P, 5^1P, 6^1P, 2^1S, and 3^1S. It is pointed out that in the calculation of generalized oscillator strengths possible errors in the zero-angle cross sections used may cancel out, which is illustrated for the transition $1^1S \rightarrow 3^1P$. Quadrupole matrix elements have been derived for the $1^1S \rightarrow 2^1S$, 3^1S transitions. In most cases the agreement with both experimental and theoretical results of other investigations is very good. (auth)

29016 A SIMPLE MODEL FOR THE YIELD OF EXCITED HYDROGEN ATOMS AS A FUNCTION OF GAS TARGET THICKNESS. Berkner, K. H.; Kay, L.; Riviere, A. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 7: 29-31(May 1967).

A simple analytical model is presented to describe the variation in the yield of excited hydrogen atoms formed by charge exchange as a function of gas target thickness. The model enables the existence of a maximum in the yield and the size of the maximum to be predicted from a minimum of cross-section information. A prediction can also be made for the amount by which the gas target thickness can be reduced in going from the value required for optimum total atom yield to that required for optimum excited atom yield. Both the ratio m of the yield at the maximum to the yield under the target conditions and the reduction in target thickness r can be expressed in terms of only two independent variables by neglecting certain small cross sections. Values for m and r are presented as sets of curves on one diagram. From available cross-section data, values for m between 1.0 and 1.5 are predicted for H_2, He, Ne, Ar and Xe gases for energies between 25 and 75 keV. The only experimental values of m available are those for Ne, Na and Mg reported by Il'in et al. For Ne the model predicts a value of m of 1.0 at 25 keV which is in agreement with the experiment. Although values of m up to 10 were observed by Il'in et al., for Na and Mg, there is insufficient cross-section data available as yet for these materials for predictions to be made from the model. (auth)

29017 AMPLIFICATION OF LONGITUDINAL WAVES IN A NONLINEAR DIELECTRIC BY A CHARGED-PARTICLE BUNCH. Krasovitskii, V. B.; Kurilko, V. I. Zh. Tekh. Fiz., 37: 7-9(Jan. 1967). (In Russian).

An analysis is made of longitudinal oscillations of a fixed-frequency wave modeled by a two-level system for the case when the natural frequency of the medium is close to that of the wave. The initial system of equations consists of motion and continuity equations for the particles of the bunch, equations describing the properties of the medium, and Poisson's equation. It is shown that the nonlinearity of the medium determines the maximum amplitude of the wave and the intensity of the oscillations field as a function of the coordinate. The nonlinearity of the equation for the motion of the bunch can be disregarded if the particle density is not too small and if the duration of the interaction is not below a certain value (a bunch with low density is decelerated by the exciting field). The maximum field amplitude and the dependence of the amplitude of the oscillations on the coordinate were calculated. (ATD)

29018 CRITICAL MAGNETIC FIELD FOR THE MOTION OF A CHARGED PARTICLE IN A CERTAIN CLASS OF ELECTROSTATIC FIELD. Borodkin, A. S.; Martynov, E. P. Zh. Tekh. Fiz., 37: 198-9(Jan. 1967). (In Russian).

A brief discussion is presented of the motion of a charged particle in an electric field described by the potential $V = (a/2)(r^2 - 2z^2) + b \cdot \log r + p$ (r, θ, and z are cylindrical coordinates and a, b, and p are constants) in the presence of a uniform magnetic field parallel to the z axis. A formula was given for the critical frequency (half the Larmor frequency in the critical magnetic field) when the initial azimuthal velocity of the particle is zero to the case of arbitrary initial azimuthal velocity. It was found that there can be two real critical frequencies of the same sign, each corresponding to a possible motion. It was also found that if the initial radial velocity of the particle is zero, the particle can be held in a limited volume by the electrostatic field alone, in the absence of a magnetic field. (ATD)

29019 BEAM SPREAD COMPENSATION IN MAGNETIC DEFLECTING SYSTEMS. Kladnitskii, V. S. Zh. Tekh. Fiz., 37: 85-91(Jan. 1967). (In Russian).

The transfer matrix formalism was used to discuss the electron optics of beam deflecting systems consisting of two or three sector-shaped uniform magnetic fields. Systems that shift the beam parallel to itself, as well as systems that deflect the beam, are discussed. Conditions for achromaticity and afocality are derived, and the focal point between the two sector fields, when there is one, is located. The position of the focal point when the afocality condition is not satisfied is also calculated. The deflecting systems are discussed from the point of view of their use for selecting a beam with a small momentum spread from the ion beam from an accelerator, and it is concluded that in some cases the relatively simple sector deflecting systems can be satisfactorily employed for that purpose in place of more complex systems involving quadrupole lenses. (ATD)

29020 SPIN AND ORBITAL SYMMETRY IN CORRELATED MANY-ELECTRON STATES. Paulus, K. F. G. J. Chem. Phys., 46: 3078-87(Apr. 15, 1967).

A detailed discussion of the requirements of spin and orbital symmetry in the pair-correlation theory of Sinanoğlu is presented. The reasons why the theory of Sinanoğlu does not satisfy these requirements a priori are exposed, and it is shown that if some modifications to it are made then the symmetry properties can be incorporated in his scheme without undue complications. This is illustrated by a number of examples, and the relation to other recent work on this problem is pointed out. (auth)

29021 COUPLING BETWEEN NUCLEAR AND ELECTRONIC MOTION IN DIATOMIC MOLECULES. Laue, Hans (Yale Univ., New Haven). J. Chem. Phys., 46: 3034-40(Apr. 15, 1967).

A general theory of the coupling between nuclear and electronic motion in diatomic molecules is presented. Special consideration is given to the case of large nuclear separation. It is shown that, for large separation of nuclei, the electronic–nuclear coupling terms are of the order of the isotope effect. The physical meaning of an (R^{-2})-dependent potential, which was found by Dalgarno and McCarroll, is explained as a centrifugal effect associated with a certain rotation of the electrons within the atoms. It is not significant at large separations. (auth)

29022 SEMIEMPIRICAL POTENTIAL AND BOUND STATE OF THE ^{4}He DIATOM. Bruch, Ludwig W.; McGee, Ian J. (Univ. of Wisconsin, Madison). J. Chem. Phys., 46: 2959-67(Apr. 15, 1967).

Hybrid potentials for the ^{4}He–^{4}He system composed of the theoretical short-range repulsion, an empirical potential at the minimum, and the theoretical long-range attraction have been constructed. Second virial coefficients calculated for these potentials are in poor agreement with experimental data. A semiempirical potential is constructed, which fits the data well. This potential becomes the theoretical interaction at large separations; its gross features are a core radius of 2.645 Å and a potential minimum of -1.73×10^{-15} erg at 2.975 Å. There is one weakly bound state of the helium-4 diatom with a binding energy of roughly 0.01°K. An analysis of the effect of uncertainties in the experimental data upon these results is included; the bound state remains even with the allowed uncertainties. (auth)

29023 MECHANISMS OF EXCITATION OF LUMINESCENCE IN NITROGEN GAS BY FAST ELECTRONS. Brocklehurst, B.; Downing, F. A. (Univ. of Sheffield, Eng.). J. Chem. Phys., 46: 2976-91(Apr. 15, 1967).

The light emission from nitrogen excited by an electron beam (50 kV; 0 to 30 μA) has been studied at pressures between 1 and 770 mm Hg. Impurity emissions (from OH, O, NO, CN) are easily excited; their importance is exaggerated by their relatively low quenching rates. The intensities of the strong N_2 emissions — N_2^+ first negative and N_2 second positive — are (usually) proportional to current; collisional quenching of these systems has been studied, in the latter case, as a function of ν'. These and other data are used to derive G values for the production of excited states of N_2 and impurities. The intensities of the weaker emissions from N_2 and of the impurity bands are not proportional to current. The excitation mechanisms are discussed in the light of estimates of the equilibrium concentrations of ions, atoms, and other active species. (auth)

29024 QUADRUPOLE MOMENT OF THE HYDROGEN MOLECULE. Karl, G.; Poll, J. D. (Univ. of Toronto). J. Chem. Phys., 46: 2944-50(Apr. 15, 1967).

Various matrix elements of the quadrupole moment of H_2 in the ground electronic state are calculated in the adiabatic approxima-

tion and the results are presented. These matrix elements of the form $\langle vJ|Q|v'J'\rangle$, where v, J and v', J' denote the vibrational and rotational quantum numbers of the initial and final states, respectively; Q represents the quadrupole moment for fixed nuclei. The calculations are based on the adiabatic potential and electronic quadrupole moment computed by Kolos and Wolniewicz. The results of the calculations are compared with experimental values obtained from the quadrupole absorption spectrum by Fink, Wiggins, and Rank. The influence of the rotation–vibration interaction on the matrix elements is discussed and an estimate of the contribution due to nonadiabatic effects is given for the case $\Delta v = 0$. (auth)

29025 X-RAYS AND THEIR APPLICATIONS. Brown, J. G. London, Iliffe Books Ltd., 1966. 258p. 65s.

Subjects covered include generation, measurement and detection, absorption and scattering, diffraction, and refraction and reflection of x rays, x-ray spectroscopy, health hazards and safety precautions, radiography, x-ray crystallography, and spectroscopic and other applications of x rays. (UK)

29026 INTRODUCTORY ATOMIC PHYSICS. Yarwood, J.; Close, K. J. London, Longmans, Green, and Co., 1966. 164p. 12s. 6d.

An account is given of the following topics: Structure of matter, electric currents in ionized gases, arrangements of electrons in atoms and the periodic table, x rays, nuclear physics and radioactivity, principles of semiconductors and semiconductor devices. (UK)

29027 INTERMEDIATE ATOMIC AND NUCLEAR PHYSICS. Harrison, A. W. London, Macmillan Co., 1966. 279p. 36s.

The following topics are dealt with: The electron and electronics, fundamental particles, atomic structure, the nucleus, particles and waves, radioactivity, artificial nuclear transformations, neutrons, nuclear fission and fusion, radiation detectors, applications of radioisotopes. A section is devoted to laboratory work, including introductory and more advanced experiments. (UK)

Cosmic Radiation

Refer also to abstracts 28242, 28893, 28924, 29303, 29461, and 29886.

29028 (NP-16481) DIE HOOGTEAFHANKLIKHEID VAN KOSMIESE STRALE MET BEHULP VAN GEIGERTELBUISE EN 'N IONISASIEKAMER. (The Altitude Dependence of Cosmic Radiation Measured by Geiger Counters and Ionization Chambers). Van Tonder, Cornelius Johannes Hercules (Potchefstroom Univ. for C. H. E. (South Africa)). Dec. 1964. 68p. (In Dutch). Dep. Thesis.

The altitude and latitude dependence of cosmic rays was investigated. The altitude dependence was measured with a balloon detector system consisting of a telescope, a single Geiger counter, and an ionization chamber. The latitude dependence was measured with an ionization chamber in an airplane at a height of 30,000 ft. from 10° 20′ to 55° 41′ south geographic latitude. The ionization chamber was a pulsed electrometer integrating type with a gold plated quartz fiber to charge the inner electrode. The Geiger counters were of the Victoreen IB85 type. The geometric factor of the telescope for omnidirectional isotropic flux was 6.92 cm^2 ster. The equation $C = Ae^{-X/L} - Be^{-X/l}$ was used as a sufficiently accurate description of the counting rate C of a single Geiger counter as a function of the atmospheric depth x. The equation was fitted to the single counter curve and the values for the parameters A, B, and L obtained were compared with those of Sparmo. A too high intensity with atmospheric depth was registered at Potchefstroom, which was not explainable. An increase of intensity of cosmic rays with increasing latitude was obtained but a smaller increase than was observed by Meher. (tr-auth)

29029 MEASUREMENTS OF THE NUCLEONIC COMPONENT IN THE LOWER ATMOSPHERE. Simionati de Fritz, N. A.; Cicchini, A. A. (Escuela Superior Tecnica del Ejercito, Buenos Aires). Nuovo Cim. (10), 49B: 220-1(June 11, 1967).

Results of measurements of the attenuation coefficient α of the nucleonic component in the lower atmosphere obtained with the neutron monitor are given. Also, results from observations carried out with a second detector, a $^{10}BF_3$ counter surrounded by paraffin and cadmium are presented. These results do not exhibit the effect ($a\ \partial\alpha/\partial P$) change in sign at pressure of 526 ± 52 mmHg) found using the first counter and the attenuation coefficient continues to increase with greater atmospheric depth. For both detectors L values of 142 ± 3 and 142 ± 2 are found. (J.F.P.)

29030 ENERGY SPECTRUM OF COSMIC RAYS IN AN EVOLVING UNIVERSE. Hillas, A. M. (Univ. of Leeds, Eng.). Phys. Lett., 24A: 677-8(June 5, 1967).

If the most energetic cosmic-ray protons originated in powerful radio galaxies, they were probably produced much more abundantly in the past. Their subsequent interactions with the cosmic microwaves could have produced a steepening in the energy spectrum as observed. (auth)

29031 SOME COSMIC-RAY SOURCES BETWEEN 0° AND -60°. Hesse, P. W.; Talbott, F. L.; Cowan, C. L. (Catholic Univ. of America, Washington, D. C.). Astrophys. J., 148: L73-9(May 1967).

The tracks of muons produced by neutral cosmic rays in a 1-m^3 spark chamber, when projected onto the celestial sphere, define a number of regions which apparently contain the sources of the neutral primaries. (auth)

29032 PHENOMENOLOGICAL CHARACTERISTICS OF BROAD ATMOSPHERIC SHOWERS WITH A FIXED NUMBER OF μ MESONS AND ELECTRONS. Vernov, S. N.; Khristiansen, G. B.; Abrosimov, A. T.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1685-9 (Oct. 1966). (In Russian).

In an earlier work by Vernov et al. (Izv. Akad. Nauk. SSSR, Ser. Fiz., 29: 1676(1965)), results obtained in a study at an installation of Moscow State Univ. on broad atmospheric showers with zenith angles of 0 to 30° were reported. These results included the distribution of showers with a fixed number of electrons N_e with respect to the number of high-energy mesons N_μ and the age parameter S, distribution of showers with a fixed N_μ with respect to N_e and S, and the coefficients of the correlation between S and the fluxes of electrons and μ mesons. In the work reported in this instance, the same relations were determined for broad atmospheric showers with zenith angles of 30 to 45°. The fluctuations of N_μ, S, and N_e, observed for an effective atmospheric depth of 1240 g/cm^2, were the same as those for vertical showers established in the earlier work. To determine the differences due to an increase in the effective atmospheric depth of 200 g/cm^2, calculations must be carried out with greater statistical precision. When results of the theoretical calculations on characteristics of broad atmospheric showers at 1240 g/cm become available, the experimental data reported will be useful for the determination of the composition of primary cosmic radiation in the superhigh-energy range. (JPRS)

29033 GROUPS OF PARTICLES AT A DEPTH OF 40 METERS ENTERING INTO THE COMPOSITION OF BROAD ATMOSPHERIC SHOWERS. Vernov, S. N.; Khristiansen, G. B.; Nechin, Yu. A.; Stoyanova, D. A.; Khrenov, B. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1694-6(Oct. 1966). (In Russian).

A study of the flux of particles at a depth of 40 m underground was made using the Moscow State Univ. installation for the investigation of broad atmospheric showers. The purpose was determination of the shower-forming capacity of particles belonging to non-Poisson groups observed in the vicinity of the axis of showers. By assuming that the particles present in the groups observed were muons and using the experimental data obtained, it was estimated that the average energy of muons in these shower-forming groups was $10^{12} < E_\mu < 10^{13}$ eV. The determination of the shower-forming capacity is of value in estimating the full amount of energy carried away by a muon group in a broad atmospheric shower. It was shown that the muons in a group have an energy of $\sim 10^3$ BeV $< E_\mu <$ 10^4 BeV. This indicates that a muon group cannot carry away more than 10% of the energy of a primary particle, and therefore cannot be responsible for the escape of a significant amount of energy in the atmosphere. Presence of concentrated groups of high-energy muons ($E \geq 10^{12}$ eV) at a depth of 40 m cannot be explained from the standpoint of theoretical concepts concerning the development of broad atmospheric showers that have hitherto been advanced. (JPRS)

29034 MEASURING THE COHERENT RADIOEMISSION OF EXTENSIVE AIR SHOWERS OF COSMIC RAYS. Borzhkovskii, I. A.; Volovik, V. D.; Shmatko, E. S. (Kharkov State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1705-7(Oct. 1966). (In Russian).

Experimental results on the coherent radio emission of extensive air showers of cosmic rays are reported. Measurements were made using a system which included 24 east–west oriented dipoles. The effective area of the antenna was 950 m^2; the minimum received threshold of radioemission was 10^{-23} $w.m^{-2} \cdot cps^{-1}$. After amplification, detection, and discrimination the antenna signal passing through a delay line was applied to Geiger–Mueller counters with the counting rate of 4.5 showers/hour. Flashes of Cherenkov light were registered by two FEU-44 photomultipliers, which were installed 46 m from the center of the antenna. The viewing angle of the light receivers was 90° and the minimum threshold sensitivity was 400 photon $\cdot$ cm^{-2}. Measurements were made at $\gamma =$

23.6 m during clear moonless nights only. During 42 hours of operation, 36 radio pulses from extensive air showers were registered. The system was operated with Geiger–Mueller counters for 40 hours. Only 3 pulses were recorded during that period. It is concluded that signals with energy $>6 \times 10^{18}$ eV were effectively registered. (ATD)

29035 METHOD OF INTRODUCING BAROMETRIC CORRECTIONS INTO COSMIC-RAY INTENSITY DATA. Dorman, L. I.; Kovalenko, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow. Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 715-16(1966).

Translated from Geomagn. Aeronomiya, 6: 922-3(1966).

Equations are given for expressing the relationship between cosmic-ray intensity and pressure. The change of intensity is computed for various cutoff rigidities at a given pressure, and the results are tabulated. (J.H.M.)

29036 SHIELDING EFFECTS AND COSMIC-RAY INTENSITY BEYOND THE ATMOSPHERE. Skryabin, N. G.; Sokolov, V. D.; Shafer, Yu. G. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 716-17(1966).

Translated from Geomagn. Aeronomiya, 6: 924-5(1966).

Experiments on geophysical rockets and on the Elektron 2, Cosmos 6, and Cosmos 19 satellites indicate that there is some difference in cosmic-ray intensity measured by individual shielded and unshielded gas-discharge counters. The results of these experiments are presented. (J.H.M.)

29037 COSMIC-RAY VARIATIONS DURING BAY-LIKE MAGNETIC DISTURBANCES. Danilov, A. A. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 646-9(1966).

Translated from Geomagn. Aeronomiya, 6: 837-41(1966).

The variations during bay-like magnetic disturbances are analyzed from data on the neutron cosmic-ray component. It is found that during bay-like disturbances, which appear on magnetically quiet days, the amplitude of the diurnal variation increases, whereas such an effect is not observed during bay-like disturbances appearing in the "tail" of a global storm. The increase in magnitude (in the first case) at Northern and Southern Hemisphere stations is symmetric with respect to the earth's equator. (auth)

29038 STUDY OF HIGH-ENERGY MUONS AT A COMPLEX INSTALLATION. Bezus, V. A.; Gedevanishvili, L. D.; Kazarov, R. E.; Kirillov-Ugryumov, V. G.; Kotov, Yu. D.; Kuridze, R. V.; Rozental', I. L.; Sakvarelidze, I. I. (Inst. of Physics, Tbilisi, USSR. Moscow Engineering Physics Inst. Tbilisi State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1662-5(Oct. 1966). (In Russian).

A study of high-energy cosmic muons was carried out at an installation consisting of an ionization calorimeter located in a tunnel at a depth of 130 m from the surface and five groups of hodoscopic counters on the surface which recorded showers accompanying the muons. The experimentally determined ionization burst spectrum of the muons could be described by the equation $T(>k) = T_0 k^{-\gamma}$, where k is the magnitude of the burst expressed in an equivalent number of relativistic particles. γ was 2.0 at k = 1000 to 4000, which corresponded to γ of 2.5 for the vertical flux of muons. The principal contribution to the bursts recorded was made by muons with an energy of $3 \times 10^{11} - 2 \times 10^{12}$ eV. At a projection angle $\leq 70°$, at which no more than two adjacent ionization chambers in the six vertically arranged rows in the ionization calorimeter operated, γ was 2.2. During 765 hours of operations, corresponding to 1100 recorded bursts, the latter were accompanied by broad showers ($N_e = 5 \times 10^4$ to 5×10^5) in nine cases. From a statistical standpoint, this result was insufficient for definite conclusions with regard to the correlation between muons and showers. (JPRS)

29039 NON-ELECTROMAGNETIC INTERACTIONS TO SUPERHIGH-ENERGY MUONS. Borog, V. V.; Kirillov-Ugryumov, V. G.; Petrukhin, A. A.; Shestakov, V. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1666-8(Oct. 1966). (In Russian).

The nonelectromagnetic interactions of superhigh-energy muons ($E \gtrsim 10^{11}$ eV) were recorded at an installation for the study of cascade showers produced by cosmic radiation muons impinging at large zenith angles (cf. Borog et al., Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1669(1966)). The only known process which could give rise to the nonelectromagnetic cascade showers recorded was that of the nuclear interaction of muons. A comparison of the spectra of nuclear and electromagnetic showers made it possible to evaluate the cross section $\delta_{\gamma N}$ of the photonuclear process at $E \gtrsim 10^{11}$ eV. By using the relation derived by P. & D. Kessler (Compt. Rend., 244: 1896(1957)), which applies to any transmitted energies, it was established that $\delta_{\gamma N} = 0.15^{+0.30}_{-0.10} \times 10^{-28}$ cm^2 per nucleon. (JPRS)

29040 STUDY OF THE ENERGY SPECTRUM OF COSMIC-RAY MUONS ON THE BASIS OF ELECTRON–PROTON SHOWERS. Borog, V. V.; Kirillov-Ugryumov, V. G.; Petrukhin, A. A.; Rozental', I. L.; Shestakov, V. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1669-73(Oct. 1966). (In Russian).

At present, outer space is the only accelerator of particles with superhigh energies. The energy spectrum of electromagnetic cascades produced by superhigh-energy muons ($E_\mu \gtrsim 10^{11}$ eV) impinging at angles $\geq 55°$ was studied at sea level on an ionization calorimeter consisting of six rows of Ar-filled ionization chambers, 25 in each row, with an iron interlayer between the chambers acting as an absorber. The majority of the cascades recorded were due to the interaction of muons with the absorber. A small number of showers (<1%) was produced by nuclear-active particles. The energy spectrum of the muons was determined on the basis of the recorded showers due to high-energy photons and electrons formed by interaction of the muons with atoms of the absorber. Mathematical equations expressing the experimentally determined energy spectrum curves were derived. (JPRS)

29041 SOLAR MODULATION OF COSMIC RAYS AND ITS RELATIONSHIP TO PROTON AND HELIUM FLUXES, INTERSTELLAR TRAVEL, AND INTERSTELLAR SECONDARY PRODUCTION. Durgaprasad, N.; Fichtel, C. E.; Guss, D. E. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 2765-82(June 1, 1967).

The general problem of solar modulation of the galactic cosmic radiation is examined with particular emphasis on the solar wind model and a comparison to the experimental cosmic-ray data obtained during the period from 1959 through 1965. It is shown that the experimental data available at present allow only limited conclusions to be drawn unless restrictions are placed on the unmodulated spectra. Within the framework of the Parker model a number of possible assumptions about the cosmic-ray source spectra are investigated, and the results are found to be rather insensitive to the form chosen for the diffusion coefficient. The contribution of secondary protons produced in intergalactic space was included in the analysis, but was not found to have any major effect on the results of the analysis. Also, the importance of particle deceleration in the solar wind was considered. Although the degree of deceleration is somewhat difficult to estimate, the particular shape of the measured spectrum tends to make the analysis insensitive to the deceleration effect. In all cases studied the modulation of the derived source spectra, assuming a reasonable variation of the modulation parameters, agree with the observed proton and helium nuclei spectra for other years. Using observed 1963 proton-to-helium nuclei ratio as a function of energy, assumed source spectra with similar energy per nucleon and similar rigidity are investigated. In the former case, it is found that source spectra with unrealistically high intensities at low energy are predicted. The case of similar rigidity spectra, on the other hand, leads to source spectra that have reasonable intensities. Finally, assuming a helium spectrum deduced from an analysis of the spectra of the multiply charged components, a proton source spectrum is derived. This leads to markedly different source spectra for protons and helium nuclei. (auth)

29042 QUASI-BIENNIAL CYCLES IN COSMIC-RAY INTENSITY. Maeda, Kaichi (Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Sci., 24: 320-3(May 1967).

The 26-month variation in the tropical stratosphere is considered, and it is pointed out that atmospheric variations may also appear in certain cosmic ray data, particularly muons. Preliminary results are shown from a power spectrum analysis of ion-chamber data from Huancayo, Peru, and Cheltenham, Md., for the period 1937 to 1959. The bands present in the spectrum include these peaking at 24 months. (D.L.C.)

29043 KOSMICHESKIE LUCHI. SBORNIK STATEI. NO. 7. (Cosmic Rays. Articles. No. 7). Vernov, S. N.; Dorman, L. I. (eds.). Results of researches on the International Geophysical Projects. Moscow, Izdatel'stvo Nauka, 1965. 283p.

Separate abstracts were prepared for the thirty papers contained in this volume. (W.D.M.)

For abstracts of individual papers see: 29044–29073.

29044 STUDIES OF 11-YEAR VARIATIONS OF COSMIC RAYS (ACCORDING TO THE DATA OF OBSERVATIONS MADE BY INSTRUMENTS AT SEA LEVEL). Dorman, I. V.; Dorman, L. I. pp 5-17 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

From measurements of the latitudinal effects of cosmic-ray neutrons and the hard component at sea level and measurements of proton and α-particle fluxes at low energies made in the strato-

sphere on balloon probes, 11-year variations of cosmic rays were studied in accordance with the data of the neutron-monitor network. Peculiarities of the lag of cosmic-ray intensity variations in regard to solar activity variations are revealed. Hysteresis phenomena were studied by neutron-monitor data and observations in the stratosphere. For $R \geq 3$ Bv an energetic spectrum of 11-year variations in the form of $\delta D(R)/D(R) \sim R^{-(0.8 \text{ to } 0.4)}$, passing on to a steeper one with $R \gtrsim 13$ Bv γ being 2 is deduced. A joint consideration of the spectrum of 11-year variations and lag phenomenon made it possible to determine the path for scattering depending on the rigidity of particles and sizes of modulating volume. Magnetic strengths in scattering inhomogeneities were determined assuming different correlation between mean sizes of inhomogeneities and the distance between them. (auth)

29045 COSMIC-RAY VARIATIONS AND SOME CHARACTERISTICS OF INTERPLANETARY SPACE. Krymskii, G. F.; Kuz'min, A. I.; Skripin, G. V. pp 18-26 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Main characteristics of cosmic-ray primary variations obtained by the IGY and IGC materials are considered. Main characteristics of variations obtained are compared with different physical models of interplanetary magnetic field and its basic parameters are determined for the chosen model. (auth)

29046 SOLAR WIND AND ITS DISPLAY IN COSMIC-RAY VARIATIONS. Dorman, L. I.; Kaminer, N. S. pp 27-9 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Main experimental data on variations of cosmic rays resulting in a conception of the solar wind as a radial flux of magnetic field inhomogeneities from the sun are discussed. The characteristics of the solar wind modulation of galactic cosmic rays in the solar system are evaluated. (auth)

29047 RESULTS OF STUDIES OF COSMIC-RAY VARIATIONS IN YAKUTSK IN 1957–1960. Kuz'min, A. I.; Krymskii, G. F.; Krasil'nikov, D. D.; Shafer, Yu. G. pp 30-8 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A review of the main results of studies of cosmic-ray variations accomplished by the Yakutsk laboratory in 1957–1960 is given. (auth)

29048 ELECTROMAGNETIC CONDITIONS IN INTERPLANETARY SPACE (BY THE DATA OF COSMIC-RAY VARIATIONS DURING THE PERIOD FROM MARCH 13 TO MARCH 20, 1958). Dorman, L. I.; Chkhetiya, A. M. pp 39-49 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Variations of cosmic rays during the period from March 13 to March 20, 1958 are studied in accordance with the materials of the world network of stations and characterization of electromagnetic conditions in interplanetary space at this period is given. (auth)

29049 ANALYSIS OF A NUMBER OF COSMIC-RAY EFFECTS DURING THE MAGNETIC STORM OF THE PERIOD OF MAXIMUM OF SOLAR ACTIVITY. Alaniya, M. V.; Dorman, L. I.; Kebuladze, T. B.; Koiava, V. K.; Koridze, V. G.; Chkhetiya, A. M. pp 50-66 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A study of the magnetic storm on October 22, 1958 showed that a number of effects exists in cosmic rays. On the basis of the analysis of the first harmonic of the diurnal wave before, during, and after geomagnetic disturbance an increase of amplitude and a displacement of phase to the earlier hours is shown. The displacement of phase remains as well during the renewal of normal intensity. An increase of intensity of cosmic rays during the main phase of the magnetic storm is observed. Planetary distribution of increase amplitude, longitudinal, and latitudinal effects is found. A comparison of characters of interaction of corpuscular streams with geomagnetic field during maximum and minimum of solar activity makes it possible to come to a conclusion that they do not differ essentially from each other because the variations of cutoff rigidity in the maximum is of the same nature as in the minimum of solar activity. (auth)

29050 A COMPARISON OF COSMIC-RAY INTENSITY VARIATIONS AND VARIATIONS OF H COMPONENT OF GEOMAGNETIC FIELD. Dorman, L. I.; Chkhetiya, A. M. pp 67-83 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

According to observations of cosmic-ray neutron component intensity and the H component of the Earth's magnetic field, it is shown that there are six types of magnetic storms characterized by the relations of different nature between cosmic-ray variations and the geomagnetic field. It is also shown that the accepted determination of magnetic storm duration is inexact. Consideration of a restoration phase of the H component of the geomagnetic field leads to a conclusion that the durations of magnetic storms and Forbush effects in cosmic rays are of the same order. (auth)

29051 A STUDY OF A NUMBER OF COSMIC-RAY EFFECTS DURING MAGNETIC STORMS IN AUGUST OF 1958 (BY THE DATA OF THE WORLD-WIDE NETWORK OF IGY STATIONS). Alaniya, M. V.; Dorman, L. I.; Koiava, V. K.; Kebuladze, T. V.; Koridze, V. G.; Chkhetiya, A. M. pp 84-99 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Great attention has been paid to studies of individual cases of variations of cosmic-ray intensity during magnetic storms and it has been shown that the characteristics of the corpuscular stream, interplanetary medium, and variations of cutoff rigidity threshold of geomagnetic field changes from one case to another. A number of effects of cosmic rays during magnetic storms for the period from August 13 to August 31, 1958, using the data of the IGY world network of stations, is considered. (auth)

29052 STUDY OF ANOMALIES IN COSMIC-RAY INTENSITY DURING MAGNETIC STORMS. Dorman, L. I.; Kolomeets, E. V.; Pivneva, V. T. pp 100-3 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Two events in the increase of cosmic-ray intensity in the minimum of the Forbush effect are considered. The dependence of the effect on geographic longitude and cutoff rigidity is given. Energetic spectra of both events are computed. Different nature of these effects is indicated. (auth)

29053 COSMIC-RAY VARIATIONS DURING MAGNETIC STORMS OF DIFFERENT TYPE. Blokh, Ya. L.; Dorman, L. I.; Kaminer, N. S. pp 104-6 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A model of the Forbush-effect mechanism based on the scattering of primary cosmic rays by regular magnetic fields of corpuscular streams, scattering inhomogeneities being present, made it possible to evaluate, quantitatively, parameters of streams and frozen-in fields. Such an evaluation is made from the data of more than 40 Forbush effects recorded during the IGY period. The width of the corpuscular stream is computed, the nature of the Earth's getting into the stream is determined, and the strength of the frozen-in field and its configuration is estimated for each individual event. It is shown that the front of the stream is characterized by a considerable (5 to 10 times) strengthening of the field which explains a rapid decrease of cosmic-ray intensity. The anisotropic increase of intensity before the Forbush-effect commencement was experimentally found. It was caused by the reflection of cosmic rays from the forward magnetized stream front. Anisotropic increase of cosmic-ray intensity in the minimum of the Forbush effect is revealed to be caused by peculiarities of interaction of the corpuscular stream with the geomagnetic field. The corpuscular stream coming out from a solar active region and its distribution in the interplanetary medium are discussed. Other mechanisms of cosmic-ray modulation during periods of high solar and geomagnetic activity are discussed in a critical way. (auth)

29054 COSMIC-RAY VARIATIONS AND SOME EVENTS OF GEOPHYSICAL COMPLEX IN AUGUST–SEPTEMBER OF 1959. Dorman, L. I.; Chkhetiya, A. M. pp 107-11 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

According to satellite observations of radiation belts, observations of cosmic rays on the world-wide ground network of stations, and observations of elements of the geophysical complex by observatories, the existence of a close correlation between the above-said factors in August–September, 1959 is shown. A synchronous change of radiation intensity in the belts was observed, as well as a change of cosmic-ray neutron component intensity, geomagnetic field H component, critical frequency of the F2 layer, and E_y strength of the earth currents. (auth)

29055 ON THE DIRECTED ANISOTROPY IN FORBUSH-EFFECT MECHANISM. SPATIAL DISTRIBUTION OF PREDECREASE MOMENTS. Fedchenko, K. K. pp 112-20 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The paper which is a continuation of the author's work published under the same title presents a quantitative discussion of the results obtained earlier with an estimation of the amplitude of Forbush decreases. In addition to 17 Forbush effects for the IGY period considered earlier, two more big Forbush decreases for 1959 are analyzed as a result of which the anisotropic nature of this effect is established. An association with magnetic storms is con-

sidered and a regularity in the sudden commencements of magnetic storms in regard to the moments of the beginning of intensity decreases of cosmic rays coming from different directions is revealed. Some considerations in favor of conceptions put forward earlier by other authors on the nature of intensity predecreases of the observed Forbush effects and also on some features of interplanetary magnetic fields are given. An averaged time–direction diagram is drawn according to which some moments of the beginning of predecreases are predicted and are compared with 12 observed predecreases at 32 stations of the worldwide network. Good agreement of the predicted moments with the observed ones made it possible to ascertain the regularity in distribution of predecrease moments all over the world. (auth)

29056 EFFECT OF THREAD-LIKE EQUATORIAL RING CURRENTS ON RIGIDITY OF GEOMAGNETIC CUTOFF OF DIRECTED COSMIC RADIATION. Dorman, L. I.; Tyasto, M. I. pp 121-30 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Numerical computations of cutoff rigidity of charged particles arriving at different angles to the zenith were carried out assuming a western thread-like current symmetric relative to the dipole axis and located in the equatorial plane. Results were obtained for geomagnetic latitudes 0, 10, 20, 30, 40, 50, and 60°, ring radii 3, 5, and 9 Earth's radii, effective magnetic moments of the ring 1, ½, and 2 magnetic moments of the Earth's dipole and for zenith angles of particle arrival to the Earth of 0, 15, 30, 45, 60, 75, and 90°. (auth)

29057 EFFECT OF THE WESTERN CURRENT ON GEOMAGNETIC CUTOFF RIGIDITY. Dorman, L. I.; Tyasto, M. I. pp 131-4 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The influence of equatorial ring currents distributed through the magnetosphere on geomagnetic cutoff rigidity of cosmic rays is computed. Computations are carried out for currents of different strength and different distances from the Earth's center. (auth)

29058 COSMIC-RAY VARIATIONS AND MAGNETOSPHERE OSCILLATIONS. Chirkov, N. P.; Krymskii, G. F.; Kuz'min, A. I.; Skripin, G. V. pp 135-9 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Variations of cosmic rays during geomagnetic storms caused by a change of geomagnetic cutoff rigidity and their dependence on characteristics of the storm are considered. (auth)

29059 ON A DISPLAY OF THE EFFECT OF ENVELOPING OF THE EARTH'S MAGNETOSPHERE IN COSMIC RAYS. Dorman, L. I.; Chkhetiya, A. M. pp 140-4 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

According to data from the world network of stations recording cosmic-ray neutron and hard components and the data from the world network of magnetic observatories, an increased peak of the Forbush effect observed underground on July 15, 1959, at 14:00 UT is studied in detail. It is shown that this peak cannot be associated with the arrival of solar cosmic rays at the Earth. An analysis of spatial distribution and correlation between variations of cosmic-ray intensity and the H component of the geomagnetic field shows that the effect may represent a new phenomenon, reflection of cosmic rays by the Earth's magnetosphere enveloped by the flux of solar plasma. (auth)

29060 STELLAR–DIURNAL VARIATIONS IN COSMIC-RAY INTENSITY. Dorman, L. I.; Ivanov, V. I.; Kolomeets, E. V.; Kashkarov, I. E.; Mirkin, L. I. pp 145-7 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

To find stellar–diurnal variations, the data on cosmic-ray intensity obtained with the help of the cross telescope at the Alma-Ata stations for 1962 and the data obtained with the help of telescopes recording particles falling in a vertical direction at the Kampala station (for 1957–1958) and the Linkoln station (for 1957–1961) are analyzed. (auth)

29061 DIURNAL AND SEMIDIURNAL VARIATIONS OF COSMIC-RAY HARD COMPONENT AND MAGNETIC ACTIVITY. Alaniya, M. V.; Kebuladze, T. V.; Koiava, V. K.; Koridze, V. G.; Chkhetiya, A. M.; Shatashvili, L. Kh. pp 148-60 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Using observations of the intensity of the cosmic-ray hard component at Tbilisi for 1953 to 1955 taken by means of a screened ionization camera, diurnal and semidiurnal variations of cosmic rays, both on quiet and on disturbed days, are studied. (auth)

29062 27-DAY VARIATIONS OF COSMIC RAYS AND A GENERAL CHARACTERIZATION OF ELECTROMAGNETIC CONDITIONS IN INTERPLANETARY SPACE. Dorman, L. I.; Shatashvili, L. Kh. pp 161-4 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Twenty-seven-day variations of cosmic rays were studied using the data of the world network of stations for the 1957–1960 period. On the basis of the results a general characterization of the features of asymmetric flux of the magnetic field inhomogeneities in interplanetary space is given. (auth)

29063 EFFECT OF ANISOTROPY IN WEAK FLARES OF COSMIC RAYS. Smirnov, V. S. pp 165-9 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

From diurnal variations for days with increased activity of solar flares an anisotropy of weak flares of cosmic rays was studied. As a measure of flare activity use was made of the summarized area of all the flares observed during 24 hours on the visible hemisphere of the Sun. An analysis was carried out separately for quiet (in regard to Forbush-type decreases and magnetic disturbances) and disturbed days. It is shown that in diurnal variation (Murmansk station data for days with increased activity of solar flares) a considerable increase is observed at 2:00, local time, for the period of 1959–1960. A suggestion is made that this increase is caused by solar particles coming in at an angle of ~60° westward of the Earth–Sun line. An analysis of diurnal variation according to the data of the Churchill station for the same period confirmed the above assumption concerning the nature of this increase, whereas for the 1957 to 1958 period, diurnal variation by the data of the same station does not show any considerable disturbances. (auth)

29064 RELATION OF THE EFFECTS OF WEAK FLARES OF COSMIC RAYS TO A_p CHARACTERISTIC OF GEOMAGNETIC ACTIVITY AND THE PROBLEM OF THE NATURE OF DISTRIBUTION IN INTERPLANETARY SPACE OF HIGH-ENERGETIC PART OF SOLAR COSMIC RAYS. Dorman, L. I.; Sergeev, A. V. pp 170-3 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

An association of the effect of weak flares of cosmic rays with the A_p characteristic of geomagnetic activity is considered as well as the question of the nature of the distribution of the high-energy part of the solar cosmic rays in interplanetary space. (auth)

29065 SOME METHODIC QUESTIONS OF STUDYING COSMIC-RAY VARIATIONS ON THE BASIS OF IGY EXPERIENCE. Blokh, Ya. L.; Dorman, L. I.; Kaminer, N. S.; Miroshnichenko, L. I. pp 174-7 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Computations of the expected effects of solar cosmic-ray flares for different instruments and distribution of stations all over the world with different assumptions on the index of differential spectrum of additional flux pulses are presented. A theoretical computation of multiplicity of μ-meson generation for different thicknesses of the absorber at sea level with one-dimensional approximation is given and coupling coefficients for telescopes recording μ-mesons at sea level and at different depths under the ground are computed. Computations of coupling coefficients for minimum and maximum of solar activity are presented and a method of determination of coupling coefficients for any moment of solar activity is developed. It is shown that the knowledge of absolute instrumental constants (world correlation of all uniform instruments) makes it possible to more precisely determine the spectrum of primary variations up to ~15 BeV. The importance of studying primary variation by a complex method with the use of data by different instruments is shown. The necessity of considering possible latitudinal anisotropy of sources of primary variations while studying energetic spectra of primary variations (for this it is important to take into account the data of crossed telescopes) is pointed out. (auth)

29066 ANALYSIS OF POSSIBLE EFFECTS CAUSED BY MAGNETIC CHARGES IN COSMIC SPACE. Dorman, L. I.; Okulov, Yu. I. pp 178-96 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Different effects which may be caused by neutrinos in cosmic space are discussed on the basis of a scalar magnetic charge unequal to 0. The value of the neutrino charge is evaluated by the experimental data on ionization cross section while the particles go through the substance. The motion of the magnetic charge in the magnetic fields of different type occurring in cosmic space is considered. A solution to the problem on the motion of particles with any energy in the field of the Earth's dipole is obtained. It is shown that for low energy particles closed trajectories are possible while moving in the dipole Earth's field. An analysis of some experiments is made to control this hypothesis. (auth)

29067 ESTIMATION OF COUPLING COEFFICIENTS FOR THE μ-MESON COMPONENT IN THREE-DIMENSIONAL MODEL OF ELEMENTARY PROCESSES. Viskov, V. V.; Dorman, L. I. pp 197-203 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

To count integral multiplicity and coupling coefficients of the meson component of cosmic rays for the event of a primary particle falling at an arbitrary zenith angle a theoretical conclusion on formulae is given. Some results of estimating computations are given as carried out on the basis of the obtained formulae. (auth)

29068 AVERAGING OF THE DATA OF OBSERVATION OF COSMIC RAYS ON THE WORLDWIDE NETWORK OF STATIONS. Alaniya, M. V.; Dorman, L. I. pp 204-7 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

By studying solar–diurnal variations of cosmic rays it is shown how great are the errors resulting from averaging of the observational data from the world network of stations according to the general formulas with a deduction of mean arithmetical values of intensity. The necessity of averaging of all the data on assimilation of the mass of observations by the formulas is discussed, correcting for each station. (auth)

29069 USE OF COSMIC RAYS FOR SOLUTION OF GEOLOGICAL-GEOPHYSICAL PROBLEMS. Blokh, Ya. L.; Bondarenko, V. M.; Tarkhov, A. G. pp 208-25 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A description of a new geophysical method of search and prospecting for minerals based on the use of penetrating cosmic radiation is given. Physical characteristics of the method are described as well as the instrumentation and the results of its application on a deposit of the Soviet Union. It is stated that ore minerals on the curves of cosmic radiation intensity are marked by minimum. The method may be also used to determine mean densities of rocks. (auth)

29070 SCINTILLATOR APPARATUS FOR STUDYING COSMIC RAYS. Abrosimov, A. T. pp 226-39 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

In 1962 experiments were started on the study of cosmic radiation with the help of a system of scintillation counters. In the installation 20 detectors were used with an area of 10 m^2; they made it possible to record flux densities in wide ranges and relative times of cosmic particle arrival. A description of the apparatus of scintillation counters is given. The most important characteristics of the instruments are presented and the data of certain basic control experiments are given. At present experimental data obtained during the work in 1962 and 1963 are being reduced, therefore only some methodic results of a preliminary reduction are given. (auth)

29071 DETECTORS OF COSMIC RADIATION USING SCINTILLATION COUNTERS. Abrosimov, A. T.; Blokh, Ya. L. pp 240-50 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Some questions of the operation of scintillation counters used in physical installations to record cosmic radiation are considered. Details are given concerning the design of the counters depending on the assumed purpose of the counter, the method of accumulation of scintillating light from phosphorus, and the amplitudinal properties of the counters. Several types of typical experiments are pointed out which should be carried out to determine the main features of the phosphors and scintillation counters. (auth)

29072 STUDY OF SHORT-PERIODIC AND MICROVARIATIONS OF COSMIC-RAY INTENSITY BY MEANS OF NEW APPARATUS. Abrosimov, A. T.; Blokh, Ya. L. pp 251-9 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The application of neutron monitors, cubic and azimuth telescopes, underground telescopes, and other detectors to study short-period variations with superhigh statistic precision is discussed. A number of problems are indicated which may be solved with these methods. The possibility of studying a new region of variations of radiation intensity is shown (microvariations with the period of the order of minutes and less). The questions associated with the application of scintillation techniques for these problems and questions associated with the use of photomultipliers for scintillation counters are considered. (auth)

29073 LIQUID SCINTILLATING DETECTORS OF LARGE SIZE. Abrosimov, A. T.; Klokh, Ya. L.; Pomanskii, A. A. pp 260-79 of Kosmicheskie Luchi. Vernov, S. N.; Dorman, L. I. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The main advantages of scintillation solutions in regard to other particle detectors are analyzed. Peculiar features of scintillation solution components are considered. Applications of a number of prospective solvents for scintillation solutions are described in detail. Factors influencing the effectiveness of scintillators and the development of big scintillation counters are reviewed. (auth)

Direct Energy Conversion

Refer also to abstracts 28138, 28172, 28173, and 30241.

29074 (BNL-11300) NON-EQUILIBRIUM IONIZATION BY METASTABLE EXCITED SPECIES IN NUCLEAR MHD CYCLES. Manowitz, B.; Powell, J.; Zucker, M. (Brookhaven National Lab., Upton, N. Y.). [nd]. 50p. (CONF-670317-1). Dep. CFSTI.

From Magnetohydrodynamics and Electrohydrodynamics Steering Committee Conference, Upton, N. Y.

The possibility of non-equilibrium ionization by metastable excited species for increased efficiency in an MHD generator is discussed. Considerations are given to theoretical calculations of conductivities, experiments, and applications to nuclear systems. (J.H.M.)

29075 (UCRL-17437) DETERMINATION OF WORK-FUNCTION DISTRIBUTION ON METAL SURFACES FROM SURFACE IONIZATION. Koenig, Daniel R. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 5p. (CONF-670320-3). Dep. CFSTI.

From 27th Annual Conference on Physical Electronics, Cambridge, Mass.

The fraction of an emitter surface occupied by patches having a given work function can be determined from the ion current–voltage characteristics of vapor diodes. The analysis assumes that emitted ions and atoms are in thermal equilibrium with the emitter surface, transport or space charge effects are negligible, the surface coverage of vapor particles on the emitter is always too small to alter its work function, and the ion emission from each patch is uninfluenced by the neighboring patches. A general expression for the emitter work-function distribution is derived in terms of the first and second derivatives (with respect to the applied voltage) of the observed ion current–voltage curve. (auth)

29076 (UCRL-70282) OUTPUT POWER CHARACTERISTICS OF THERMIONIC CONVERTER ARRAYS UNDER PARTIAL FAILURE CONDITIONS. Long, James R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 24, 1967. Contract W-7405-eng-48. 31p. (CONF-670806-1). Dep. CFSTI.

For Presentation at 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla.

The output characteristics of thermionic converter arrays are determined as a function of interconnection scheme, interconnection resistance, converter failure modes and patterns, and converter characteristics. The arrays consisted of series strings of converters paralleled with each other by resistive interconnections. The use of additional interconnections is considered to form three-dimensional arrays in which edge effects inherent in planar arrays are eliminated. From an analytical point of view, the applicability of a strictly linear model for the converter is improved with three-dimensional arrays. The output of a three-dimensional array under failure conditions is not significantly greater than that of a planar array, and array shape does not have a strong influence on power output. The array reliability is shown to be greater than the converter reliability. A study of the effect of introducing a statistical distribution of converter parameters appears to show less power loss under failure conditions. A study of the effect of matching the load impedance of a failed array shows that the impedance change is small. (auth)

29077 PROBLEMS OF THE COAL-FIRED MHD POWER PLANT. Way, S. (Univ. of California, Santa Barbara). pp 235-56 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

Problem areas of the MHD-steam combined plant are examined. Among these problems are those of the coal combustion system, the MHD duct walls, the large superconducting magnet, the high-temperature air preheater, the seed recovery system, and the exhaust gas purifier used to prevent air pollution. (auth)

29078 DIRECT ENERGY CONVERSION AND ASTRONAUTICS. Gourdine, M. C. (Gourdine Systems, Inc., Livingston, N. J.). pp 273-80 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

Ideas about generating electric power in space are examined. The conclusions stemming from this examination indicate that direct-energy conversion, rather than conventional energy-conversion techniques, will have to play a major role in future astronautic systems. (auth)

29079 SPACE-POWER SUBSYSTEMS DEVELOPMENT STATUS AND OUTLOOK. Reams, James D. (Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio). pp 11-30 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966.

An assessment is made of the technological states of space electric power subsystems. Quantitative parametric data and improvement trends are presented for various concepts. Since space power subsystems by design are categorized in two separate and distinct groups, the following two categories are treated individually: energy-limited subsystems (concepts which use an expendable energy source) and power-limited subsystems (concepts which employ an essentially nonexpendable energy source). (J.H.M.)

29080 ADVANCED RADIONUCLIDE GENERATORS WITH THERMOELECTRIC CONVERTERS. Zahn, P. (Boelkow GmbH, Ottobrunn, Ger.). pp 151-73 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The serviceability of radionuclide generators with thermoelectric converters for use in rocket systems was evaluated. The state of the technology in the production of such generators is described and the requirements with respect to space technology are outlined. The serviceability of a generator was also evaluated on the basis of its geometry and the heat source used. (J.S.R.)

29081 THERMOELECTRIC GENERATORS FOR HIGH POWER. von Szabo, E. (Siemens-Schuckertwerke AG, Erlangen, Ger.). pp 175-87 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The constituents of thermoelectric generators are outlined and the parameters of the building element are given. The electrical data of a generator constructional element are summarized. The technology of the thermoelectric element is outlined. Two examples are given of high-power generators: a reactor thermoelectric energy power system and a radionuclide thermoelectric system. (J.S.R.)

29082 RADIONUCLIDE GENERATOR WITH THERMIONIC CONVERTER. Hannemann, D. (Entwicklungsring Nord, Bremen). pp 221-34 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

An isotope battery using ^{90}Sr in the form of strontium oxide is described. The energy converter, the construction design, the heat insulation, the heat irradiation, and the radiation protection are discussed. Applications of such a battery are briefly considered. (J.S.R.)

29083 ON THE CONSEQUENCES OF A CONVERSION PROCESS WITH A TWO-PHASE MATERIAL FLOW. Radebold, R. (Allgemeine Elektricitaets-Gesellschaft, Berlin). pp 249-57 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

A liquid-metal MHD converter with a multistage thermodynamic drive is discussed as an alternate to thermionic converters. The coexistence of liquid and gaseous phases outside the MHD converter is shown. The construction of the steam power plant and MHD baffle radiation tube is illustrated. A velocity diagram and flux scheme for the thermodynamic transformation in the MHD aggregate is shown. (J.S.R.)

29084 PRELIMINARY EXPERIMENTS IN THE MHD RESTRICTING JET TUBE PROJECT. Lang, H.; Schulz, T.; Radebold, R. (Allgemeine Elektricitaets-Gesellschaft, Berlin). pp 259-69 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The experimental work done on the development of an MHD restricting jet tube project is outlined. The purpose of the development work was to determine whether an inductive MHD converter with reasonable power, efficiency, and output factors could be developed. The efficiency with which a liquid metal as working medium for the converter could be accelerated thermodynamically was also investigated. The inductive energy coupling was tested using NaK as the working medium. (J.S.R.)

29085 CRYOGENIC TECHNOLOGY FOR ENERGY SUPPLIES IN SPACE. Carpetis, C. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt e. V., Stuttgart). pp 271-85 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The purpose of the application of cryogenic technology in energy supply installations consists principally in the cooling of individual components of the energy supply system to a temperature range from 4 to 30°K. In this temperature range two important phenomena occur: superconductivity and the very strong reduction of the electrical resistance of metals. The uses of superconductivity in dc MHD converters is shown. The application of cryogenic technology in ac MHD converters is discussed. The application of cryogenic technology to superconducting inductive accumulators is also considered. (J.S.R.)

29086 MHD POWER GENERATORS IN CENTRAL STATIONS. Tsu, T. C. (Westinghouse Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Spectrum, 4: No. 6, 59-60(June 1967).

The broad area of MHD power generation is surveyed, with emphasis on its application to central stations. Following a brief discussion of the MHD principle, three types of combined power plants are described: the coal-burning MHD–steam power plant, the noble-gas MHD generator with a nuclear heat source, and the liquid-metal MHD generator. Design problems and operating characteristics are presented, together with possible advantages and problem areas. (auth)

29087 RESEARCH ACTIVITIES ON MHD POWER GENERATION AT ELECTROTECHNICAL LABORATORY. Fushimi, Kozo. Denki Shikensho Iho, 31: 129-35(1967). (In Japanese).

A general view is given of research activities on MHD power generation at the Electrotechnical Laboratory. The major purpose of the research is to develop an open-cycle MHD power plant. The research work on MHD was initiated in 1961 with preliminary experiments with a small device using argon–potassium plasma. The Mark-I generator driven by combustion product of propane and oxygen was built in 1962, generating electrical power about 0.7 kW. The Mark-II generator was constructed in 1965 on the basis of the experimental results on the Mark-I, and has been under operation for the test running, with a maximum output of about 155 kW. The Mark-II uses diesel oil as fuel and oxygen as the oxidizer. It is 24 MW in thermal input, 3.5 tesla in magnetic flux density, and its channel is 120 cm in length, 10 × 10 cm in cross-sectional area at the inlet and 10 × 25 cm at the outlet. It is planned to modulate the Mark-II generator so as to use preheated air (up to 1650°K), and to construct the Mark-III generator in 1967 as a facility for long-duration tests. The electrode materials and superconducting magnets are also investigated. The electrodes of some borides such as ZrB_2 were made and were examined by means of the Mark-I generator. A superconducting magnet for the generator is under construction. (auth)

29088 THERMIONIC CONVERSION SPECIALIST CONFERENCE, HOUSTON, TEXAS, NOVEMBER 3 AND 4, 1966. New York, Institute of Electrical and Electronics Engineers, 1966. 443p. $15.00. (CONF-661116).

Fifty-nine papers on various aspects of thermionic conversion are presented. Principal topic areas are: devices, plasma properties, fossil fuel thermionics and heat pipes, solar thermionics, materials, cesium reservoirs, theory, and surface physics. (J.H.M.)

Fluid Physics

Refer also to abstracts 28167 and 29074.

29089 MAGNETO-FLUID-MECHANIC CHANNEL FLOW. II. THEORY. Lykoudis, P. S.; Brouillette, E. C. (Purdue Univ., Lafayette, Ind.). Phys. Fluids, 10: 1002-7(May 1967).

A semi-empirical theoretical analysis is presented describing the fully established turbulent channel flow of an electrically conducting fluid in the presence of a transverse and uniform magnetic field. The channel is assumed to be electrically insulated and of such geometry that two-dimensional flow prevails. The magnetic Reynolds number is assumed to be small so that the distortion of the externally imposed magnetic field is negligible. A straightforward generalization of Prandtl's mixing length concept, providing for the damping of the turbulent fluctuation is sufficient in predicting skin friction coefficients and velocity profiles over the whole range of Reynolds and Hartmann numbers for which experimental data are available, is established. (auth)

29090 MAGNETO-FLUID-MECHANIC CHANNEL FLOW. I. EXPERIMENT. Brouillette, E. C.; Lykoudis, P. S. (Purdue Univ., Lafayette, Ind.). Phys. Fluids, 10: 995-1001(May 1967).

An experiment is described in which fully developed turbulent channel flow of mercury was investigated in the presence of a uniform transverse magnetic field. The channel test section was constructed from an electrical insulator and was rectangular in cross section. The flow was studied in the range of Reynolds numbers: 58 000–180 000, based on channel equivalent diameter. Hartmann number was varied between zero and values sufficiently high to change the flow from turbulent to laminar at the corresponding Reynolds number. Skin friction coefficients were deduced from static pressure measurements along the length of the channel. Velocity profiles were obtained from traversing probe total head measurements. (auth)

29091 MAGNETOHYDRODYNAMIC FLOW IN TUBES WITH LONGITUDINAL ELECTRIC CURRENT. Regirer, S. A. Prikl. Mat. Mekh., 31: 356-62(Mar.-Apr. 1967). (In Russian).

Certain general properties of completely developed MHD flow in circular tubes in the presence of longitudinal electric current were analyzed. Examples are given of precise solutions showing that the thickness of the boundary layer, on the walls parallel to the field, is of the $M^{-\frac{1}{2}}$ order (where M is the Hartman number). (R.V.J.)

29092 INVESTIGATION OF THE NONSTEADY FLOW OF A CONDUCTING LIQUID IN A MAGNETOHYDRODYNAMIC CHANNEL. Ryabinin, A. G.; Khozhainov, A. I. Zh. Tekh. Fiz., 37: 222-8(Feb. 1967). (In Russian).

The nonsteady flow is discussed for a viscous conducting liquid in a magnetohydrodynamic channel of rectangular cross section, two opposite walls of which are conductive and are short circuited through a resistive load, for the case when the magnetic Reynolds number is small compared with unity. An approximate solution is first obtained for the case when there is a constant-pressure gradient, the uniform external magnetic field is perpendicular to the nonconducting walls, and the nonconducting walls are much wider than the conducting ones. This solution reduces to previously known solutions in several limiting cases. By introducing the further simplifying assumption that the viscous loss divided by the velocity of the fluid is close to its asymptotic value during the acceleration of the fluid, an approximate solution is derived for the more difficult case of arbitrary ratio of the widths of the walls of the rectangular channel. A simple approximate expression is derived for the velocity of the liquid as a function of time. (ATD)

29093 STUDY OF FLOW IN MAGNETOHYDRODYNAMIC SHOCK TUBES. Nguyen-Ngoc-Tran (Centre de Calcul Analogique, Hauts-de-Seine, France). Compt. Rend., Ser. A, 264: 574-7(Mar. 20, 1967). (In French).

The hypothesis where the magnetic interaction parameter N is of the order of unity is considered. The case where the flow can be linearized is studied and resolved completely. The resolution method used is applied to the small N scheme. (tr-auth)

29094 EXPERIMENTAL STUDY OF THE CHARACTERISTICS OF A HYDRAULIC CIRCUIT USABLE FOR THE FURTHER FOCUSING OF LOCAL VELOCITY MEASUREMENT DEVICES IN MAGNETOHYDRODYNAMIC FLOW. Amy, Josette; Dorlhac, Francois; Poirier, Yves (Faculte des Sciences, Bouches-du-Rhone, France). Compt. Rend., Ser. A, 264: 578-80(Mar. 20, 1967). (In French).

An experimental study was made of the hydraulic properties of a pipe of constant rectangular cross section operating in closed circuit. The experimental results and the theoretical curves tracing the velocity distribution in different planes of the flow in the pipe of viscous and electroconducting liquid were compared. (tr-auth)

29095 FIZIKA UDARNYKH VOLN I VYSOKOTEMPERATURNYKH GIDRODINAMICHESKIKH YAVLENII. (Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena). Zel'dovich, Ya. B.; Raizer, Yu. P. Moscow, Izd-vo Nauka, 1966. 688p.

A wide circle of questions from different areas of physics, physical chemistry, and astrophysics dealing with contemporary gas- and hydrodynamics is examined. The principles of gasdynamics and of shock wave theory and radiation transfer theory are given. The thermodynamic and optical properties of materials at high temperatures and pressure, kinetic dissociation, ionization, and other nonequilibrium processes, phenomena connected with irradiation and radiating heat exchange in shock waves and during explosions, and questions on the propagation of shock waves in solids are studied. (tr-auth)

Geophysics

Refer also to abstracts 28869, 28935, 28941, and 29037.

29096 (AD-636138) HYDROMAGNETIC WAVE PROPAGATION NEAR 1C/S IN THE UPPER ATMOSPHERE AND THE PROPERTIES AND INTERPRETATION OF PC 1 MICROPULSATIONS. Dawson, John A. (Institute for Telecommunication Sciences and Aeronomy, Boulder, Colo.). June 30, 1966. 71p. (NBS-TN-342). CFSTI.

Dispersion and polarization relations are developed from basic considerations for a hydromagnetic wave at about 1 cps propagating in a cold uniform plasma. The treatment is then extended to include the effects of ion–electron collisions. At lower elevations the plasma must be considered as nonuniform. Above 50,000 km the small amplitude assumption is invalid. Finally the theory is extended to include the effects of a multicomponent plasma. A reasonable hydromagnetic model for the propagation of pc 1 micropulsations is one in which Alfven (left-hand) waves travel along field lines to reach the earth's surface at auroral latitudes and then propagate equatorward. The isotropic right-hand wave is constrained to a duct between 400 and 2000 km above the earth by refractive processes. It is shown how many of the observed properties of pc 1's can be related to such a model. Mechanisms for the generation of pc 1's are also discussed and it is concluded that particle instabilities are the most likely source. (auth)

29097 (N-66-38867) ELECTRON DENSITIES AND SCALE HEIGHTS IN THE TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS OVER THE AMERICAN CONTINENTS. VOLUME II. MARCH AND MAY 1963. Chan, Kwok-Long; Colin, Lawrence; Thomas, John O. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1966. 610p. (NASA-SP-3032). CFSTI $3.00 cy, $0.65 mn.

Tabulations are presented on the data analyses of the Alouette I topside sounder ionograms. In this pole-to-pole study, data are given on the electron density and plasma scale height at various heights and times in the topside ionosphere. (STAR)

29098 (N-67-14933) ELECTRON DENSITIES AND SCALE HEIGHTS IN THE TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS OVER THE AMERICAN CONTINENTS. VOLUME III. JUNE–SEPTEMBER 1963. Chan, Kwok-long; Colin, Lawrence; Thomas, John O. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1966. 584p. (NASA-SP-3033(Vol.3)). CFSTI $3.00 cy, $0.65 mn.

Data on electron density and plasma scale height at various heights and times in the topside ionosphere are presented in tabular form. The data were computed from Alouette I topside sounder ionograms. Information is given on the Alouette satellite, selection of ionograms, and use of the tabulations. (STAR)

29099 LABORATORY GEOPHYSICS AND ASTROPHYSICS. Bachynski, M. P.; Osborne, F. J. F. (RCA Victor Co. Ltd., Montreal). pp 3-43 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

Laboratory simulation of geophysical and astrophysical phenomena, indicating the scaling requirements and describing the significance of various scale-model experiments which have been carried out including those on solar wind–magnetosphere interaction, ionospheric wave phenomena and resonances, vlf communications via the ionosphere, sheaths surrounding satellites, and perturbations of the space environment by rockets and space vehicles are examined. Areas where future simulation experiments could prove valuable are suggested. (auth)

29100 LABORATORY SIMULATION OF SOLAR WIND PHENOMENA. Patrick, R. M.; Pugh, E. R. (AVCO Everett Research Lab., Everett, Calif.). pp 45-62 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

A facility was built which produces a steady flow of high-conductivity, collision-free plasma with a characteristic flow dimension large compared to the ion gyro radii. A description of this facility and the design criteria are given. The results of the calculation of the plasma flow in the field annihilation region between the solar wind and the magnetopause is reviewed, and the most recent experimental results obtained in the plasma wind tunnel facility are given. (auth)

29101 ELECTRIC POTENTIALS, FORCES, AND TORQUES ON BODIES MOVING THROUGH RAREFIED PLASMAS. Wood, G. P.; Hohl, F. (Langley Research Center, Hampton, Va.). pp 99-133 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

The electrodynamic forces and torques on charged bodies moving through the rarefied and partially ionized upper atmosphere and magnetic field of the earth are discussed. The charge distribution, the potential distribution, the forces due to increased cross section for ion impacts and due to the $j \times B$ effect are calculated for Echo II, which is a sphere 41 meters in diameter. The various electrodynamic torques that can affect the spin rate of satellites are examined. The possibility of a transfer of charge between rendezvousing spacecraft, during the docking maneuver, of sufficient intensity to cause damage is also studied. Extreme situations are considered and it is shown that even for the extreme cases the problem is not at all a severe one. (auth)

29102 INTERPLANETARY PLASMA. Snyder, Conway W. (California Inst. of Tech., Pasadena). pp 327-31 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

The idea that a dilute plasma escaping from the solar corona fills the solar system and constitutes "the interplanetary medium" is discussed, and a listing of important research in the field is given. (M.O.W.)

29103 PROTON-IRRADIATION DARKENING OF ROCK POWDERS: CONTAMINATION AND TEMPERATURE EFFECTS, AND APPLICATIONS TO SOLAR-WIND DARKENING OF THE MOON. Nash, Douglas B. (California Inst. of Tech., Pasadena). J. Geophys. Res., 72: 3089-3104(June 15, 1967).

Darkening of silicate rock powders by bombardment with 2- to 16-keV protons was found to be slight unless proton flux or total proton incident-power density is sufficient to produce sample surface temperature in excess of about 150°C. Darkening then increases with incident power density for a given proton dose; i.e., the darkening is rate dependent as well as dose dependent. The darkening is due to contamination by (1) carbon from irradiation decomposition of hydrocarbon vacuum contaminants and/or (2) metal atoms deposited on the sample surface from sputtering of ion source components. The photometric properties of the contamination-darkened samples are similar to those reported for samples darkened with hydrogen ions by Hapke and by Wehner et al.; this result suggests that contamination darkening may have caused the photometric modifications that they report; a review and comparison of experimental apparatus and procedures is presented. The experimental conditions under which silicate powders darken by proton or hydrogen-ion bombardment are shown to be unrealistic for simulation of solar-wind darkening of the moon's surface. It is suggested, however, that deposition of solar carbon on the moon may occur in sufficient amounts to produce darkening. (auth)

29104 PARAMETERS OF THE OPTICAL PROPERTIES OF THE LUNAR SURFACE POWDER IN RELATION TO SOLAR-WIND BOMBARDMENT. KenKnight, C. E.; Rosenberg, D. L.; Wehner, G. K. (Litton Systems, Inc., Minneapolis). J. Geophys. Res., 72: 3105-29(June 15, 1967).

The optical properties of the moon are quantitatively compared with those of powder samples bombarded by ions from a hydrogen discharge plasma. Deficiencies in the simulation of the solar-wind bombardment include contaminants deposited on, and injected into, the sample surfaces. Also an unknown fraction of the sputtered atoms returns to the lunar surface after flight in the gravity field. The variable albedo of the powder samples due to darkening by ion bombardment is studied in relation to parameters of color, photometric function, and polarization while holding composition, surface structure, or powder particle size fixed. Simulation of the solar wind was not adequate to permit identification of lunar compositions from lunar color. The lunar photometric function requires a rough macrostructure. A number of properties of the photometric function plus the polarization of earthshine, however, are shown to be incapable of presently proving whether the lunar surface is underdense or compacted. A polarization parameter indicates a lunar powder whose particles are mostly less than 0.1 mm in size. Effects expected from solar-wind bombardment include surface darkening and decoloration, erosion, preferential erosion of some substances, dust cementation, and alterations of surface layer composition. (auth)

29105 SIMULTANEOUS OBSERVATIONS OF SOLAR PROTONS INSIDE AND OUTSIDE THE MAGNETOSPHERE. Krimigis, S. M.; Van Allen, J. A.; Armstrong, T. P. (Univ. of Iowa, Iowa City). Phys. Rev. Lett., 18: 1204-7(June 26, 1967).

Simultaneous observations of low-energy (~0.5 MeV) protons emitted in a solar flare of 7 July 1966 were made with detectors on board the earth satellites Explorer 33 and Injun IV, located outside and inside the earth's magnetosphere, respectively. We find that such protons have full and essentially immediate access from interplanetary space to the polar caps of the earth. (auth)

29106 POLARIZATION AND INTENSITY MEASUREMENTS OF HYDROGEN LYMAN-ALPHA IN THE DAY AIRGLOW. Heath, Donald F. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 148: L97-100(May 1967).

Measurements were made of polarization and intensity in the day airglow of Lyman-α. The polarization and intensity were measured as a function of altitude for the principal far-ultraviolet day airglow emission features from 1200 to 2000 Å. These included the hydrogen Lyman-α line at 1216 Å, the resonance lines of O I at 1304 Å, and the group at 1355 Å, and an unidentified source of emission in the region from 1450 to 2000 Å. The experiment was flown on an Aerobee 150 rocket from White Sands. (W.D.M.)

29107 INFLUENCE OF CORPUSCULAR RADIATION ON THE CIRCUMTERRESTRIAL CLOUD. Tverskoi, B. A. Soviet Astron. AJ (Engl. Transl.), 10: 1031-3(May-June 1967).

Translated from Astron. Zh., 43: 1289-91(Nov.-Dec. 1966).

Cathode sputtering of dust particles in the earth's proton radiation belt is discussed. The effect seriously limits the lifetime of particles captured by the earth. An estimate is made for the contribution of the solar wind in reducing the orbital eccentricity of particles revolving about the Sun; this effect is comparable with the influence of sunlight. (auth)

29108 ORIGIN OF INHOMOGENEITIES IN THE F2-LAYER OF THE IONOSPHERE. Kovalenko, V. S.; Troitskii, B. V. (Siberian Physical-Technical Inst., Tomsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 717-20(1966).

Translated from Geomagn. Aeronomiya, 6: 925-7(1966).

Plasma instability of the trough type is proposed as the mechanism of formation of ionospheric inhomogeneities. Allowance is made for gravity, regular density gradients, and the nonisothermal state of the plasma. (J.H.M.)

29109 IONOSPHERIC TURBIDITY. Vsekhsvyatskaya, I. S.; Kushnerevskii, Yu. V.; Smirnova, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 721-3(1966).

Translated from Geomagn. Aeronomiya, 6: 928-30(1966).

In order to study the turbidity of the ionosphere, an investigation is made of the diurnal and seasonal pattern of the ratio of energies of specularly reflected and scattered radio signals. (J.H.M.)

29110 VARIABILITY OF THE IONOSPHERE. Misyura, V. A.; Migunov, V. M.; Solodovnikov, G. K. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 723-5(1966).

Translated from Geomagn. Aeronomiya, 6: 931-2(1966).

Satellite data on the variation of ionospheric electron concentration with respect to time are analyzed to determine the variability of the ionosphere. (J.H.M.)

29111 EXPERIMENTAL STUDY OF THE SPECTRUM OF A PULSE SIGNAL REFLECTED FROM THE IONOSPHERE. Kokourov, V. D. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 725-6(1966).

Translated from Geomagn. Aeronomiya, 6: 933-4(1966).

The preliminary results of a study of the spectrum of a pulse signal, reflected from the ionosphere, are reported. The observations were made on a manually controlled ionospheric sounder, provided with an attachment for recording reflection on an expanded scale. (J.H.M.)

29112 LUNAR TIDES IN THE IONOSPHERE IN THE VICINITY OF THE MAGNETIC EQUATOR. Zagulyaeva, V. A.; Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 726-8(1966).

Translated from Geomagn. Aeronomiya, 6: 934-5(1966).

Lunar tide variations in the ionosphere as a function of height are studied. Data on N(h) profiles at Ibadan, located in the vicinity of the magnetic equator, were used. Curves are plotted for vertical amplitude variations of semidiurnal oscillations and the vertical phase distribution of the second harmonics of oscillations of electron concentration in the ionosphere. (J.H.M.)

29113 RELATION OF E_s TO MAGNETIC ACTIVITY. Ovezgel'dev, O.; Ostanina, M. B. (Dept. of Exploration Geophysics and Seismology, Academy of Sciences, Ashkhabad, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 729-31(1966).

Translated from Geomagn, Aeronomiya, 6: 938-9(1966).

An analysis is made of the variations of sporadic-E parameters on magnetically disturbed and magnetically quiet days. A comparison of the data shows that the diurnal patterns of the E_s parameters do not differ significantly for the observed periods. (J.H.M.)

29114 FREQUENCY DEPENDENCE OF ADDITIONAL COSMIC NOISE ABSORPTION DURING SUDDEN IONOSPHERIC DISTURBANCES. Belikovich, V. V.; Benediktov, E. A. (Gorky State Univ., USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 732-4(1966).

Translated from Geomagn. Aeronomiya, 6: 940-2(1966).

In order to observe absorption during sudden ionospheric disturbances, cosmic radio noise levels were recorded on type EPP-09 automatic recorders at a tape speed of 240 mm/hour (in 1959) and 120 mm/hour (in 1960–1963). Amplification was calibrated every hour by means of an auxiliary noise generator. Relatively narrow passbands were used to reduce noise from radio stations. More than 40 absorption bursts were recorded during the period of observation, for which it was found possible to determine the maximum absorption value, Γ, at least at two frequencies. The experimental Γ values are compared for the following pairs of frequencies: 18.6–25, 13.2–25, 8.7–13.2, and 5.7–8 MHz. (J.H.M.)

29115 DETERMINATION OF LINEAR ELECTRON DENSITY IN METEOR TRAILS. Kolomiets, A. R. (Kiev State Univ.). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 734-5(1966).

Translated from Geomagn. Aeronomiya, 6: 943-4(1966).

Linear electron density is the main characteristic of a meteor trail of any type and, therefore, the accuracy of the results of radar investigations depends on the accuracy with which linear electron density is determined. An equation is given for determining linear electron density in meteor trails. (J.H.M.)

29116 DISTRIBUTION OF THE DISTURBANCE FIELD IN THE SECOND PHASE OF THE GEOMAGNETIC EFFECT OF THE HIGH-ALTITUDE EXPLOSION ON JULY 9, 1962. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 737-8(1966).

Translated from Geomagn. Aeronomiya, 6: 945-6(1966).

Various studies of the distribution of the disturbance field in the second phase of the geomagnetic effect of the high-altitude explosion of July 9, 1962, over Johnston Island were previously reported. Some of the previous studies did not find a definite scheme in this distribution, whereas a global current system in the ionosphere, consisting of two vortexes, was constructed by Yamaguchi. An attempt is made to refine the scheme proposed by Yamaguchi on the basis of data from 72 stations. (J.H.M.)

29117 STUDY OF THE MORPHOLOGY OF THE GEOMAGNETIC FIELD BY MEANS OF AUTOCORRELATION ANALYSIS. Lugovenko, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 741-2(1966).

Translated from Geomagn. Aeronomiya, 6: 949-50(1966).

In analyzing the possibility of breaking down the geomagnetic field into two parts, the main magnetic field and the anomalous magnetic field, the most difficult and important problem is to prove that the anomaly spectrum is discontinuous. The conventional anomaly spectrum where magnetic anomalies play the role of harmonics is assumed to be discontinuous (Alldredge, 1963). An attempt is made to show the discontinuity of the anomaly spectrum by analysis of the autocorrelation function of the anomalous magnetic field. (J.H.M.)

29118 SCATTERING OF RADIO WAVES ON THE TRAIL OF A BODY MOVING IN PLASMA. Gurevich, A. V.; Pitaevskii, L. P. (Lebedev Inst. of Physics, Moscow. Inst. of Physical Problems, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 650-8(1966).

Translated from Geomagn. Aeronomiya, 6: 842-51(1966).

Computations of the scattering of radio waves on an electron concentration disturbance behind a body moving in the lower ionosphere are generalized for the case when the body crosses a layer $\epsilon = 0$. Resonance scattering on the trail of a body moving along a magnetic field line is discussed. (auth)

29119 ELECTRON CONCENTRATION IN THE OUTER IONOSPHERE, MEASURED FROM OBSERVATIONS OF COHERENT SIGNALS FROM THE COSMOS AND ELEKTRON SATELLITES. Misyura, V. A.; Solodovnikov, G. K.; Migunov, V. M. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 659-63(1966).

Translated from Geomagn. Aeronomiya, 6: 852-7(1966).

Some results are described of an analysis of records of the difference in Doppler frequency shifts of coherent radio waves emitted by the "Mayak" transmitters from Cosmos II, Elektron I, and Elektron 3 satellites. Electron concentrations along the orbits of the satellites are obtained for different times of day at middle latitudes to heights $z_E \approx 2800$ km. Electron concentration is found to be $\sim 10^4$ cm^{-3} at heights of 1800 to 2800 km. Data on the nonmonotonic decrease of electron concentration with height above the main ionospheric maximum are confirmed. (auth)

29120 KINETICS OF IONIZATION-RECOMBINATION PROCESSES IN THE F2-LAYER OF THE IONOSPHERE. Polyakov, V. M.; Shchukina, T. B. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 664-71(1966).

Translated from Geomagn. Aeronomiya, 6: 858-68(1966).

The behavior of a system of balance equations of the charged particle concentration in the F2 layer of the ionosphere is analyzed. A new method of determining the ionization–recombination parameters from a complete system of balance equations by means of analog computers is discussed. The effective charge–exchange and dissociative recombination coefficients are determined for the F2 layer. The applicability of the linear and quadratic approximations of the recombination term in the study of temporal ionization variations is discussed. (auth)

29121 RADIO COMMUNICATIONS CONDITIONS AT HIGH LATITUDES IN YEARS OF DECREASING SOLAR ACTIVITY. Kiseleva, M. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 672-6(1966).

Translated from Geomagn. Aeronomiya, 6: 869-74(1966).

A study is made of radio communications conditions on zonal links under various degrees of ionospheric disturbance. It is shown that prolonged disruptions of radio communications are observed at the time of strong magnetic–ionospheric disturbances because of anomalous absorption, of the appearance of a sporadic E, and of the closeness of the operating frequency to ulf. (auth)

29122 RECOMBINATION PROCESSES IN THE LOWER IONOSPHERE. Pudovkin, M. I. (Polar Geophysical Inst., Kola, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 677-81 (1966).

Translated from Geomagn. Aeronomiya, 6: 875-80(1966).

The characteristics of auroral ionization recombination are analyzed. The dissociative recombination rate of NO^+ ions is estimated. It is shown that allowance for the $N_2^+ + O_2 \rightarrow NO^+ + NO$ ($\gamma = 10^{-13}$–10^{-12} cm^3/sec) reaction makes it possible to explain the recombination rate in auroras, as well as in a quiet daytime ionosphere. (auth)

29123 INFLUENCE OF THE GEOMAGNETIC FIELD ON A SIGNAL IN OBLIQUE SOUNDING. Chernov, Yu. A. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 682-8(1966).

Translated from Geomagn. Aeronomiya, 6: 881-8(1966).

It is shown that in oblique sounding at night the level of the extraordinary component is approximately equal to that of the ordinary component. During the daytime, when nondeviative absorption prevails, the ordinary component exceeds the extraordinary component. The conclusion is derived from the analysis that if absorption, Γ, in one direction does not exceed 1.5 and the signal-to-noise ratio >0.2, the front of the signal corresponds to the delay of the extraordinary component. (auth)

29124 RADIAL EXTENT OF A CORPUSCULAR STREAM FROM A CHROMOSPHERIC FLARE AND THE TIME THE EARTH REMAINS IN THE CORPUSCULAR STREAM. Mustel, E. P.; Maysuradze, P. A. (Astronomical Council, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 629-33(1966).

Translated from Geomagn. Aeronomiya, 6: 815-21(1966).

The radial extent of corpuscular streams from chromospheric flares in a direction away from the sun is estimated. In this connection it is shown that the time the earth remains in a corpuscular stream is not defined by the instant at which D_{st} variations return to the undisturbed state, but much earlier. This instant coincides with the planetary cessation of irregular geomagnetic field pulsations. The geometric dimensions and the kinematic characteristics of specific corpuscular streams are estimated. (auth)

29125 GEOMAGNETIC PHENOMENA OBSERVED DURING THE TRANSIT OF THE EARTH THROUGH THE TAIL OF HALLEY'S 1910 II COMET. Ivanov, K. G.; Shevnin, A. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 634-7 (1966).

Translated from Geomagn. Aeronomiya, 6: 822-6(1966).

The data of seven Northern Hemisphere observatories are used to analyze geomagnetic phenomena observed May 18–19, 1910, during the transit of the the earth through the tail of Halley's 1910 II comet. It is shown that at this time there was a small global geomagnetic field disturbance which was approximately symmetric with respect to the instant of passage of the comet over the solar disc. Some ideas are put forward in favor of the existence of a geomagnetic effect from Halley's comet. (auth)

29126 STATIONARY STATES OF THE EARTH'S OUTER RADIATION ZONE. Trakhtengerts, V. Yu. (Gorky State Univ.,

USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 638-45 (1966).

Translated from Geomagn. Aeronomiya, 6: 827-36(1966).

The formation of the earth's outer radiation zone under the effect of a source of energetic electrons and of kinetic instability (associated with the anisotropic velocity distribution of the zone's electrons) is examined. Allowance is made for the inhomogeneity of the zone. The stationary spectrum of ulf noise and the distribution function of radiation-zone electrons are found. The results obtained are compared with experiment. (auth)

29127 LONGITUDINAL EFFECT OF AURORAL ACTIVITY. Starkov, G. V. (Polar Geophysical Inst., Kola, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 698-701(1966).

Translated from Geomagn. Aeronomiya, 6: 901-6(1966).

The influence of universal time on the diurnal variations of auroral activity is examined. It is shown that there are two maxima in the main auroral zone, at 12–13 and 23–0h UT, associated with the deformation of the diurnal auroral activity curves. (auth)

29128 ROLE OF A SHOCK WAVE IN THE FORMATION OF A GEOMAGNETIC DISTURBANCE PRODUCED BY A STRONG EXPLOSION IN THE AIR. Zolotov, A. V. (All-Union Inst. of Geophysics, Volga-Urals Branch, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 702-6(1966).

Translated from Geomagn. Aeronomiya, 6: 907-13(1966).

The possibility that a geomagnetic disturbance would form as a shock wave travels through the ionosphere as a result of additional thermal ionization of the ionosphere behind the shock wave front and as a result of the magnetohydrodynamic effect is examined. It is concluded that for an explosion of up to 10 million tons of TNT at a height below 70 to 75 km, the shock wave is of no significant importance to the formation of the geomagnetic disturbance produced by the explosion. (auth)

29129 STANDARD PROCESSING OF DATA FROM PANORAMIC VERTICAL SOUNDING OF THE IONOSPHERE ON AN ELECTRONIC COMPUTER. Galkin, A. I. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 707-11(1966).

Translated from Geomagn. Aeronomiya, 6: 914-19(1966).

The general principles and a method of analysis for the standard processing of data obtained from panoramic vertical sounding of the ionosphere on an electronic computer are described. The problem of extrapolating segments of the height–frequency characteristic for quantitative determination of the parameters of layers is examined. (auth)

29130 POSITION OF THE OVAL AURORAL ZONE ON THE NIGHT SIDE OF THE EARTH ON MAGNETICALLY QUIET DAYS. Fel'dshtein, Ya. L. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 693-7(1966).

Translated from Geomagn. Aeronomiya, 6: 894-900(1966).

The oval auroral zone is located at $\Phi' \sim 70^\circ$ on the night side of the earth on magnetically extremely quiet days ($\Sigma K_p < 10$ and $K_p \sim 0$ in the midnight hours). The magnetosphere remains asymmetric in the plane of noon–midnight meridians even when there are absolutely no planetary magnetic disturbances. (auth)

29131 RADAR RETURN FROM VEHICLES IN THE IONOSPHERE. Rand, S. (Univ. of California, San Diego, La Jolla); Albini, F. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1174-81(June 1967).

Approximate expressions are derived for radar (backscatter) cross sections of the wakes of vehicles in the ionosphere. Vehicle speed is assumed to be much greater than ion thermal speed but much less than electron thermal speed. It is shown that, under broadside incidence conditions, the large region of mild electron depletion behind the vehicle can give rise to backscatter cross sections approaching 100 m^2. The orientation of the velocity vector with respect to the local geomagnetic field is also shown to be important. (auth)

29132 ORIGIN OF FORBIDDEN $^1D_2$–$^3P_{1,2}$ TRANSITIONS IN OXYGEN. Grechikhin, L. I. (Inst. of Physics, Minsk). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 689-92(1966).

Translated from Geomagn. Aeronomiya, 6: 889-93(1966).

The conditions under which forbidden $^1D_2$–$^3P_{1,2}$ transitions originate in oxygen in various states of plasma are analyzed. It is shown that the probability of the transition depends on electron concentration in the plasma. Exchange effects are small for electron concentrations of 10^5 cm^{-3} and the probability of spontaneous transition is determined by the spin–orbit interaction. Several facts observed during auroras are explained. (auth)

29133 A STUDY OF BLANKETING SPORADIC E AT MIDDLE LATITUDES. Matsushita, S.; Reddy, C. A. (High Altitude Observatory, Boulder, Colo.). J. Geophys. Res., 72: 2903-16 (June 1, 1967).

The average daytime behavior of midlatitude blanketing sporadic E is studied on a worldwide basis. The hourly values of f_bE_s obtained at over 80 stations in 1958 were statistically analyzed to yield the latitudinal, seasonal, and diurnal variations of f_bE_s, and of the occurrence frequency of $f_bE_s \geq 2.0$ Mc. The results show that f_bE_s varies on the average in step with f_oE in all seasons at a all latitudes, suggesting a strong dependence of f_bE_s on the local f_oE value during daytime. The occurrence frequency of blanketing sporadic E shows two daytime maxima in local summer and a single afternoon maximum in local winter; further, it exhibits a rather complex latitudinal variation and considerable irregular fluctuations. It is shown that all the main characteristics of daytime blanketing sporadic E can be explained on the basis of the wind theory. (auth)

29134 CRITERIA FOR RECOGNITION OF A WINTER DAY OF HIGH IONOSPHERIC ABSORPTION. Shirke, J. S.; Narayana Rao, G. L. (Univ. of Illinois, Urbana). J. Geophys. Res., 72: 2917-27(June 1, 1967).

Criteria for identifying a winter day with anomalous ionospheric absorption were established from ground-based measurements for use when launching rockets to study the D layer under these conditions. The criteria are based on measurements of vertical incidence ionospheric absorption of 3.03 Mc at Wallops Island, Virginia, during the winter of 1965–1966 using an automatic recording system. The nature of the partial reflections observed from very low altitudes during an anomalous day and certain other features noticeable on a sensitive ionosonde are discussed. A new method of data analysis is presented whereby it is possible to separate the absorption below and above the normal E-region level in the ionosphere, using single-frequency measurements. Normally, a substantial part of the total absorption is shown to arise above 110 km depending largely on the virtual height of reflection of the echo. The anomalous absorption originating much below the 110-km level is shown to be about 8 db at its noon maximum. Various other features of the anomalous absorption are investigated including its diurnal variation, which is shown to be similar to that on the control days. (auth)

29135 IONOSPHERIC ELECTRON CONTENT AND IRREGULARITIES DEDUCED FROM BE-C SATELLITE TRANSMISSIONS. Narayana Rao, N. (Univ. of Illinois, Urbana). J. Geophys. Res., 72: 2929-42(June 1, 1967).

The radio beacon satellite BE-C has an inclination 41.2° and when observed at Urbana, Illinois (40.069°N, 88.225°W) its sub-ionospheric path extends along an almost west-to-east direction during at least one passage everyday. This circumstance permits the study of electron content variation across the sunrise and sunset lines. Faraday fading data at 40 Mhz obtained by using electrically rotating goniometer are combined with those at 40 Mhz and 41 Mhz recorded in the conventional manner by using fixed dipoles to compute the total electron content versus local time. Large-scale irregularities in electron content are obtained for each passage by computing the percent deviation of the actual content curve from a smoothed curve obtained by fitting a third-degree polynomial in the least-squares sense to the actual curve. From a comparison of the results of analysis of data gathered during the period June–December 1965 with those of others, the diurnal, seasonal, and solar cycle dependence of electron content are discussed. The rates of electron production for an overhead sun computed by two methods, one using post-sunset decay of content and noon value of content with a diffusion transport layer model and the other using the sunrise buildup of electron content with a Chapman layer model are found to be in rough agreement. An approximate power spectrum analysis of the irregularity patterns is performed and results obtained for dominant wavelengths of traveling disturbances causing the irregularities are in the same range as those calculated from internal gravity wave theory. (auth)

29136 INTERACTION OF A PLASMA CLOUD WITH THE EARTH'S MAGNETOSPHERE. Dryer, Murray (Environmental Science Services Administration, Boulder, Colo.); Merritt, David L.; Aronson, Philip M. J. Geophys. Res., 72: 2955-62 (June 1, 1967).

A number of suggestions have been made that the sudden commencement of a magnetic storm is caused by an impulsive increase of energy density at the magnetosphere. It has been proposed that the commencement at middle and low latitude is produced by the subsequent transmission of transverse and longitudinal waves to the earth's surface. An additional suggestion that the energy density increase caused by a blast wave that precedes a high-velocity plasma cloud that has been ejected during a solar flare is discussed. The dynamic interaction between such blast waves with the magnetosphere-shock combination is interpreted with the aid

of a laboratory analog. In this experiment a blast wave, produced by a shock tube, is directed downstream through a wind tunnel nozzle toward a hemisphere–cylinder model that has a standing shock associated with the original supersonic flow in the tunnel. The subsequent interaction is studied with the aid of experimental diagnostics such as high-speed shadowgraph photography and pressure transducers. The magnitude and time scale of the stagnation (i.e., subsolar) pressure history during the interaction is correctly predicted by a three-dimensional (two spatial coordinates plus time) gasdynamic numerical solution. The peak and final steady-state pressures are predicted by a one-dimensional gasdynamic analysis. This experimental and theoretical fluid analog may provide insight to an understanding of some storm phenomena such as the sudden commencement. (auth)

29137 RELATIONS BETWEEN THE DAWN MINIMUM IN THE EQUATORIAL RADIUS OF THE PLASMAPAUSE AND Dst, K_p, AND LOCAL K AT BYRD STATION. Carpenter, D. L. (Stanford Univ., Calif.). J. Geophys. Res., 72: 2969-71(June 1, 1967).

The equatorial geocentric distance to the plasmapause is known to be sensitive to the level of worldwide magnetic activity, decreasing during periods of increasing magnetic disturbance (Carpenter, 1963, 1966; Taylor et al., 1965). This relationship is clarified by providing statistics relating the plasmapause position to three different magnetic indices, Dst, K_p, and local K at Byrd Station in the auroral zone. (J.H.M.)

29138 DISCUSSION OF PAPER BY G. K. WALTERS, "ON THE EXISTENCE OF A SECOND STANDING SHOCK WAVE ATTACHED TO THE MAGNETOSPHERE." Dryer, Murray (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 72: 2977-8(June 1, 1967).

Statements concerning a second standing shock wave attached to the magnetosphere [Walters (1966)] are reviewed and analyzed. Brief discussions are included on the shape of the sonic line and the existence of the imbedded shock wave. (J.H.M.)

29139 A DETERMINATION OF THE ENERGY SPECTRUM OF EXTRATERRESTRIAL ELECTRONS IN THE ENERGY RANGE 70 TO 2000 MeV. Webber, William R.; Chotkowski, Charles (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 72: 2783-2802(June 1, 1967).

Electrons in the energy range 70 MeV to 2.4 BeV were measured at atmospheric depths of 2 to 4 g/cm^2 on two balloon flights in 1965 and 1966 from Fort Churchill, Canada. The electrons were identified using a scintillation telescope that contained a gas Cherenkov detector and a lead glass total energy spectrometer. Growth curves of electrons in four energy ranges have enabled a separation of atmospheric and extraterrestrial electrons to be made. Between 300 MeV and 2.4 BeV the extraterrestrial electron spectrum in 1965 can be approximated by $dj/dE = (30/E^{1.8})$(electrons/m^2 ster sec). This spectrum becomes much flatter at energies below 300 MeV, and the high-energy spectrum and the electrons observed at 3 to 12 MeV by Cline, Ludwig, and McDonald cannot be connected by a simple power law spectrum. The neutron monitor rate at Mount Washington was 3.2% lower at the time of the 1966 flight relative to 1965. A significant decrease in electron intensity at all energies is observed between the 1965 and 1966 flights. The extraterrestrial electron spectrum deduced to exist at sunspot minimum is compared with the "secondary" production of these electrons by cosmic-ray nuclei in the galaxy. It is estimated that these galactic secondary electrons probably account for ≤25% of all the extraterrestrial electrons at 1 BeV and ≤50% at 400 MeV. At energies between 100 and 200 MeV all of the extraterrestrial electrons can be accounted for as galactic "secondaries." The arguments relating the electron synchrotron galactic radio emission spectrum to the electrons measured at the earth are reexamined in the light of these measurements. (auth)

29140 HEAT CONDUCTION WAVES IN THE UPPER ATMOSPHERE. Volland, H. (Univ. of Bonn). J. Geophys. Res., 72: 2831-41(June 1, 1967).

In the thermosphere a temperature and pressure disturbance of the neutral air can be transported vertically by a wave mode that mainly depends on the heat conductivity of the air. In the low-frequency region ($\omega < 10^{-2}$ sec^{-1} or periods of $\tau > 10$ min) these heat conduction waves propagate with phase and group velocity proportional to the reciprocal density of the air. The mean velocity is of the order 10 to 100 m/sec within the ionospheric F region. The traveling time of a disturbance from the exosphere down into the lower F region is about 10 hours and about 2 days down into the E region. These waves may be excited by hydromagnetic waves in heights above 1000 km. Their large propagation time can explain the time delay of ionospheric storms and of the geomagnetic activity effect of the neutral air, as well as the after-storm effect of vlf phase heights in the nighttime E layer related to the time of impact of an enhanced solar wind as the beginning of a geomagnetic storm. Moreover, heat conduction waves may be the cause of ionospheric traveling disturbances excited within the exosphere and propagating downward with a phase velocity equally directed to their group velocity. (auth)

29141 THEORETICAL SIMULATION OF MICROPULSATIONS. Cocke, W. J. (Aerospace Corp., El Segundo, Calif.); Cornwall, John M. J. Geophys. Res., 72: 2843-56(June 1, 1967).

The combined processes of cyclotron instability and quasi-linear diffusion for low-energy protons are studied in some detail, and equations describing these processes are derived for a bounded plasma with reflecting walls. These equations are used by a computer to simulate micropulsation pulses (Pc 1). Average hydromagnetic wave amplitudes in the magnetosphere are calculated and are comparable to those observed on the ground in subauroral latitudes. Computed silhouette sonagrams bear a close resemblance to ground-based experimental data. Direct comparison of amplitudes can only be made with satellite data, which does not yet exist. When low-energy proton fluxes are near the saturation limit predicted by quasi-linear diffusion theory, the effective proton lifetime shows a highly nonlinear dependence on proton flux strength; the influence of this effect on radial diffusion processes is discussed qualitatively. (auth)

29142 SYSTEMATIC STUDY OF STRUCTURED MICROPULSATIONS. Kenney, J. F.; Knaflich, H. B. (Boeing Scientific Research Labs., Seattle). J. Geophys. Res., 72: 2857-69(June 1, 1967).

A micropulsation experiment is in continuous operation near Seattle, Washington, to investigate the cause and behavior of Pc 1 micropulsations. The results of this study show that certain characteristics of the data exist that allow a partial selection to be made between the various theories. The diurnal variation of the average midfrequency of the Pc 1 emissions can be described by a 24-hour harmonic curve. The amplitude of this curve undergoes time variations and also changes with magnetic activity, but the local time of the maximum of this curve is constant. Coupling these results with the data taken at different latitudes by other authors leads to the conclusion that a pearl oval exists that responds to changes in the magnetosphere with solar activity. Investigation of the repetition period of structured elements as a function of frequency shows that the majority of pearls display the characteristics of propagation through a dispersive magnetosphere and subsequent ducting through a nondispersive ionosphere. This is in agreement with the theories that specify that the repetition time between structured elements is controlled by the latitudinal bounce time of a hydromagnetic wave packet, not by the bounce time of a stream or bunch of particles. (auth)

29143 POLARIZATION ANALYSIS OF NATURAL AND ARTIFICIALLY INDUCED GEOMAGNETIC MICROPULSATIONS. Fowler, R. A.; Kotick, B. J.; Elliott, R. D. (North American Aviation, Inc., Downey, Calif.). J. Geophys. Res., 72: 2871-83 (June 1, 1967).

The polarization characteristics of geomagnetic micropulsations are investigated using quasi-monochromatic wave train theory of physical optics. The polarization of a wave train is analyzed by considering the coherency matrix of the wave field. The elements of the matrix are calculated over the desired frequency band and the polarization parameters evaluated. Since the determinant of the coherency matrix is zero for a totally polarized wave field, this property can be used to separate a partially polarized wave field into its polarized and unpolarized parts. The ellipticity, orientation, and sense of polarization for the polarized portion are then calculated in terms of the matrix elements using power and cross-power spectral analysis techniques. Based on this approach, the polarization of a number of different signals has been digitally determined. Test cases include a random number time series, a constructed signal with a predetermined polarization, and an example typical of geomagnetic micropulsations resulting from high-altitude nuclear weapons tests superimposed on high ntural background. The results of these analyses are then compared with those from the standard hodogram technique and the effectiveness of both methods discussed in terms of the signal characteristics. (auth)

29144 IONOSPHERE AT 640 KILOMETERS ON QUIET AND DISTURBED DAYS. Reddy, B. M.; Brace, L. H.; Findlay, J. A. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 2709-27(June 1, 1967).

Electrostatic probe measurements of electron concentration N_e from the TIROS 7 satellite are the basis for a study of the global response of the topside ionosphere (640 km) to magnetic disturbances at solar minimum. The quiet-time behavior of N_e shows many of the features previously evident in Explorer 22 measurements at 1000 km. These are the daytime equatorial maximum, the nighttime midlatitude maximums, and the main trough at the

boundary of the polar region. The storm-time response of the ionosphere at 640 km takes the form of strong N_e enhancements at middle and high latitudes on the dayside and smaller enhancements on the nightside. This enhancement is in contrast to present thinking, which is based on bottomside sounding and total content measurements. At the equator, the storms produce depressions of N_e on the dayside and enhancements on the nightside. Measurements of N_e and electron temperature T_e from Explorer 22 show similar but smaller N_e enhancements during storms, accompanied by slight decreases in T_e, except in the polar regions where both N_e and T_e are increased. It is concluded that the storm-time enhancements of N_e may be explained in terms of the observed thermal expansion of the neutral atmosphere that lifts the entire ionosphere, thereby increasing N_e at the fixed altitude of the observations. The different behavior of the equatorial N_e is consistent with electrodynamic drift theory. The storm-time increase of T_e in the polar region may result from additional heating, while the decrease of T_e at all other latitudes is caused by both increased collisional cooling to the expanded neutral atmosphere and by a decrease in the escape flux of photoelectrons which heat the upper F region. (auth)

29145 CISLUNAR ELECTRON CONTENT AS DETERMINED BY RADAR GROUP DELAY MEASUREMENTS. Howard, H. T. (Stanford Univ., Calif.). J. Geophys. Res., 72: 2729-35(June 1, 1967).

An earlier report described an experimental radar technique for measuring differential group delay to the moon with an accuracy of 10 μsec and presented the results of 5 measurements. These data, when combined with other radar work, showed large differences in total cislunar electron content above 1000 km in the solar and antisolar directions. It was suggested that this difference was most likely due to a high-density (several hundred electrons per cubic centimeter) plasma wake of the earth formed by the solar wind and extending at least as far as the moon. Since this interpretation is not supported by other evidence, the experiment was refined and then performed during 55 lunar meridian transits in July and August 1965. These data have been compared with ionospheric contents deduced from Faraday rotation on 136-Mhz signals from the Syncom satellite and with protonospheric content calculated using Explorer 22 1000-km Langmuir probe data. The radar data support the initial results concerning the solar-antisolar asymmetry, but the new data for the computation of electron content between 1000 km and the plasmapause (at about 4 R_E) indicate that the difference is due to plasma in this relatively unexplored region of the magnetosphere. Thus it is concluded that, within the ±30 electrons cm^{-3} accuracy of the combined measurement, the electron number density in the geomagnetic tail is not markedly different from that of interplanetary space. (auth)

29146 EXPLORER 12 MEASUREMENTS OF THE DISTORTION OF THE GEOMAGNETIC FIELD BY THE SOLAR WIND. Mead, Gilbert D. (Goddard Space Flight Center, Greenbelt, Md.); Cahill, Laurence J. Jr. J. Geophys. Res., 72: 2737-48 (June 1, 1967).

Magnetometer data from 7 passes of Explorer 12 during quiet times are compared with theoretical magnetosphere models. The data cover the region from $3\frac{1}{2}$ to 13 R_E (earth radii) and are expressed in terms of the deviation in field magnitude from a Jensen and Cain reference field, plus inclination and declination angles measured with respect to the dipole axis. Near the noon meridian and from 6 to 7 R_E out to the magnetopause, the magnitude and direction of the observed field seem to agree quite well with those predicted by the distorted magnetosphere model of Mead and Beard. Near the dawn meridian, a significant twisting of the field lines out of the dipole magnetic meridian plane is observed, corresponding to the tendency of the field to point in the antisolar direction in the southern hemisphere. From $3\frac{1}{2}$ to 7 R_E there is strong evidence of quiet-time plasma currents tending to inflate the field. In particular, the field magnitude dips well below the Jensen and Cain values at around $3\frac{1}{2}$ R_E close to the geomagnetic equator. (auth)

29147 ELECTRON AND ION ACCELERATION BY NONLINEAR WAVES NEAR THE EARTH. Gintzburg, M. A. (Inst. of Terrestrial Magnetism, Moscow). J. Geophys. Res., 72: 2749-64(June 1, 1967).

The properties of large-amplitude waves (especially these of solitary waves "solitons") are considered. In a soliton of maximum amplitude the energy of electron transverse movement equals that of ion longitudinal movement and amounts to a half of magnetic energy; hence, such structures afford an efficient mechanism transferring solar wind ion kinetic energy to the electrons. When the magnetic field and the plasma density of the undisturbed plasma are designated by H_o and n_o, the maximum field amplitude in the soliton crest equals $H_t = (H/m)^{\frac{1}{2}}H_o$ and the electron and ion energy $W_e = W_t = (\frac{1}{2})(H_o^2/8\pi n_o)(M/m)$ exceeds by three orders of magnitude that of the undisturbed field. A physical picture of this acceleration process is that the rapid time variation of the magnetic field generates a transverse electric field accelerating primarily the electrons because of their small mass. The presence of nonlinear waves with their peculiar properties may explain from a common standpoint several important geophysical phenomena: the formation of the outer radiation belt, the ring current within the earth magnetosphere, the small-scale structure of the transition region, ionization of the night ionosphere, the polar aurora, the acceleration of the solar cosmic rays in the sun chromosphere, and the formation of cometary tails of the first kind. (auth)

29148 DELINEATION OF JOVIAN DECAMETRIC SOURCES BY MILLISECOND PULSES. Olsson, C. N.; Smith, A. G. (Univ. of Florida, Gainesville. Univ. of Chile, Santiago). Nature, 214: 999-1001(June 3, 1967).

Jovian decametric emission is received in bursts of pulses forming three rather distinct groups: (a) a rare type, consisting of long pulses lasting up to tens of seconds, (b) the common variety, including pulses lasting from tenths of a second to several seconds, and (c) extremely short pulses, with durations in the millisecond range, and at times moderately common. An analysis is given of high-speed pen records of these pulses. Data suggest that group (c) radiation is especially sensitive to the position of Io. Profiles are reproduced for the 18 Mc group (c) activity versus the System III longitude of Jupiter's central meridian for eight positions of Io relative to the Earth–Jupiter line. It is also indicated that normal Jovian emission is stimulated only when Io is over the hemisphere $110° < \lambda_{III} < 290°$. Polar diagrams are shown for 18 Mc millisecond pulse activity for a range of Io positions, centered on System III longitude 210°, and on longitude 270°. "Non-Io-related" emission is considered. (UK)

29149 BRIEF INTRODUCTION TO IONOSPHERIC AERODYNAMICS. de Leeuw, J. H. (Univ. of Toronto). pp 1561-86 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The object of this paper is to discuss briefly, and mainly in physical terms, the effects associated with flight through the ionosphere, together with the basic theoretical approaches which have been used to describe in quantitative terms the properties of the flow field and effects on satellite motion. Headings are as follows: introduction, ionospheric properties, plasma flow over a body, plasma in a body at rest, structure of flow field, satellite potential, charged particle drag, plasma instabilities. (UK)

29150 TRAIL OF AN IONOSPHERIC SATELLITE. Vaglio-Laurin, R.; Pan, Y. S. (New York Univ., Bronx, N. Y.). pp 1687-1702 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

An analytic investigation of the problem from a kinetic point of view has been undertaken; perturbations of the neutral and ion gas in the far trail have been determined taking into account the effects of the geomagnetic field and of interparticle collisions, while representing the body as a point source. The analysis is here extended to recognize the interplay between length scales associated with properties of the medium (i.e., ion Larmor radius, mean free path) and the scale determined by finite body dimensions; in addition, a first approximation for the self-induced electric field in the far trail is determined. The sequential approach to the analysis is discussed and justified; a qualitative comparison with other investigations of the problem is instituted. (auth)

29151 EXPERIMENTAL STUDY OF PLASMA–VEHICLE INTERACTION. Clayden, W. A.; Hurdle, C. V. (Royal Armament Research and Development Establishment, Sevenoaks, Eng.). pp 1717-31 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

Plasma-vehicle interaction was studied experimentally with a plasma beam facility capable of reproducing the charged particle motion about a small vehicle moving at orbital velocity in the ionosphere. Measurements were made of the ion current to a family of cones, and the distribution of ions in the wake behind a sphere and a 15° semi-angle cone, as a function of body potential. (auth)

29152 SPREAD F AND ITS EFFECTS UPON RADIOWAVE PROPAGATION AND COMMUNICATION. Newman, P. (ed.). Maidenhead, Eng., Technivision , 1966. 622p. (AGARDograph-95).

Information is presented on ionospheric F-region irregularities

and their effects upon radio-wave propagation and communications. Principal topic areas are: spread F, scintillation and radio wave propagation, movements of irregularities, and production of F region irregularities. (J.H.M.)

Low-Temperature Physics

Refer also to abstract 29085.

29153 (JINR–P8-3206) KRIOGENNYE PROBLEMY SVYAZANNYE S ISPOL'ZOVANIEM KRUPNYKH SVERKHPROVODYASHCHIKH SOLENOIDOV. (Cryogenics Problems Connected With the Use of Large Superconducting Solenoids). Zel'dovich, A. G.; Shishov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 19p. (In Russian). Dep.

The processes of cooling the stabilized superconducting solenoids are considered. The schemes of refrigerators, intended for the operation with large solenoids, are discussed. Necessary capacity of helium liquefier is estimated on the basis of calculations made for a 40 kG solenoid of the JINR 5-meter hydrogen chamber. A conclusion is drawn about the ability of modern cryogenic technique to solve the problems connected with the manufacturing and operation of refrigerators for large and heavy superconducting solenoids. (auth)

29154 (N–66-30752) STUDY OF PROPERTIES OF HIGH FIELD SUPERCONDUCTORS, AC FIELD INDUCED FLUX JUMPS. Technical Summary Report, June 21, 1965–April 26, 1966. Gandolfo, D. A.; Harper, C. M. (Radio Corp. of America, Camden, N. J.). Contract NAS8-11272. 71p. (NASA-CR-76253). CFSTI.

Magnetization experiments in superimposed dc and audio-frequency ac magnetic fields have been performed on tubular samples of cold-worked Nb–50% Ti. The samples exhibited a dc field-dependent critical–current density in agreement with Kim's equation. When an ac field whose amplitude exceeded a certain threshold was superimposed on the dc field, regular flux jumps ensued. The threshold was inversely proportional to the frequency, with the dependence being stronger at frequencies below 200 cps. At low frequencies the duration of a flux jump was estimated as 2×10^{-4} sec. The flux jumps were identical in amplitude at a given frequency and strikingly similar from 6.3 to 208 cps, the most common amplitude being in the range from 400 to 500 G. Temperature measurements made with a carbon resistor in the sample interior showed that threshold fields caused the bulk sample temperature to rise by not more than 0.1°K. This small increase is in qualitative agreement with computations of the steady-state temperature rise caused by hysteresis and eddy current losses, also found to be quite small. (auth)

29155 (UCRL–70285) A LIGHTWEIGHT, 1-METER-DIAMETER, 12 kG, SUPERCONDUCTING MAGNET SYSTEM FOR A BALLOON-CARRIED COSMIC RAY EXPERIMENT. Taylor, Clyde E. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 28, 1967. Contract W-7405-eng-48. 14p. (CONF-670705–1). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

For cosmic-ray studies at high altitudes a very lightweight magnet system is required, with large aperture and with magnetic field normal to the particle path. Such a coil is being built at the Lawrence Radiation Laboratory, University of California, Livermore, for a balloon-carried experiment proposed by Professor Luis Alvarez. The complete coil and Dewar system will be tested in July 1967. The main features of this coil system including field configuration, structural problems, and construction details are discussed. (auth)

29156 OBSERVED MAGNETIC STRUCTURE OF TYPE-II SUPERCONDUCTORS. Traeuble, H.; Essmann, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Technische Hochschule, Stuttgart). Phys. Status Solidi, 20: 95-111(Mar. 1, 1967). (In German).

The superficial magnetic structures of lead–indium crystals in the mixed state at 1.1°K are demonstrated by depositing small ferromagnetic particles approximately 100 Å in diameter. The resulting powder patterns are observed using an electron microscope and the replica technique. Under favorable conditions, the method gives a resolution of about 100 Å. The present study indicates that the magnetic flux penetrates the sample surface at discrete spots about 1000 Å in diameter. Most of these spots are assembled to form clusters containing an average number of about 30 spots. When the field is increased the number of clusters increases, and the diameter of the individual clusters decreases. Within the expected accuracy of the present experiments, satisfactory agreement is found between electron-microscopic observation and measured magnetization curves if each of the individual spots is identified with a single flux line carrying one quantum of flux. Observations on thin lead–indium platelets 0.5 mm in thickness indicate the existence of an intermediate state in superconductors of the second kind having small $\varkappa$. (auth)

29157 SUPERCONDUCTING TRANSITION OF LEAD FILMS UNDER THE ACTION OF MAGNETIC FIELDS AT 4.2°K. Maldy, Jacques; Donadieu, Lucien; Santa-Maria, Enrique (Centre de Recherches de la Compagnie Generale d'Electricite, Marcoussis, France). Compt. Rend., Ser. A and B, 264: 416-19(Feb. 6, 1967). (In French).

The effect of the thickness of lead films on the order and the reversibility of the transition in a parallel field and on the type of superconductivity in a perpendicular field was studied. The results are analyzed in the light of present theories. (tr-auth)

29158 CALCULATION OF THE MAGNETIC PROPERTIES OF SUPERCONDUCTING VANADIUM. Fournet, G.; Milleron, P. F. (LCIE, Fontenay-aux-Roses, France. Univ., Paris, Fontenay-aux-Roses, France). Phys. Lett., 24A: 641-2(June 5, 1967).

An attempt is made to compare the results given by a cellular model of the mixed state with experimental data. A fairly good agreement is obtained. (auth)

29159 GEOMETRICAL EFFECTS IN THE CRITICAL CURRENTS OF TYPE-II SUPERCONDUCTORS. Lowell, J. (Oxford Univ.). Solid State Commun., 5: 323-5(May 1967).

It is suggested that the critical current of an extremely "hard" type-II superconductor may be influenced by the sample geometry in such a way that it is reduced when "demagnetizing" effects are present. (auth)

29160 SUPERHEATING AND SUPERCOOLING IN NORMAL-METAL-PLATED SUPERCONDUCTORS. Smith, F. W.; Cardona, Manuel (Brown Univ., Providence). Solid State Commun., 5: 345-7(May 1967).

Supercooling and superheating have been observed for unplated and copper-plated indium spheres. The supercooling field is H_{c3} for the unplated and H_{c2} for the plated samples. The ratio H_{c3}/H_{c2} increases with decreasing temperature. The superheating field is reduced by copper plating. (auth)

29161 CURRENT DISTRIBUTION IN A PURE TYPE-II SUPERCONDUCTOR. Jones, R. G. (Univ. of Manchester, Eng.). Solid State Commun., 5: 375-9(May 1967).

Experiments indicate that the resistanceless transport current in the mixed state of a pure type-II superconductor flows partly in the surface sheath and partly in the bulk. The bulk component obeys the Lorentz force theory, but the surface component is determined by the properties of the sheath. (auth)

29162 SOME NEW SUPERCONDUCTING GROUP V^a DICHALCOGENIDES. Van Maaren, M. H.; Schaeffer, G. M. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 24A: 645-6 (June 5, 1967).

Group V^a dichalcogenides were investigated for superconductivity down to 0.05°K. The following new superconducting compounds were found: $NbTe_2$, TaS_2, and $TaSe_2$, with maximum transition temperatures of 0.74, 2.10, and 0.22°K, respectively. No superconductivity was found in $TaTe_2$ and in the non-stoichiometric compounds VSe_2 and VTe_2. (auth)

29163 ANALOG OF THE NERNST EFFECT IN THE INTERMEDIATE STATE OF TYPE-I SUPERCONDUCTORS. Huebener, R. P. (Argonne National Lab., Ill.). Phys. Lett., 24A: 651-2 (June 5, 1967).

Transverse voltages caused by longitudinal temperature gradients were observed in the intermediate state of a type-I superconductor. The transverse voltages occur only above a "critical temperature gradient," which decreases with increasing magnetic field. (auth)

29164 NEW CORRELATION LENGTH IN BOSE-GAS MODELS OF LIQUID HELIUM. Goble, D. F.; Trainor, L. E. H. (Univ. of Toronto). Phys. Rev., 157: 167-8(May 5, 1967).

A series of calculations is reported on the thermodynamics of both ideal and hard-core Bose gases in thin-film geometry. These calculations indicate that a Bose gas at liquid-helium densities possesses a statistical correlation length of about 70 Å, representing the thickness beyond which the thermodynamic behavior of the film closely approximates that of the bulk system. Some indication of this behavior may be implicit in recent experimental results both on superfluid flow in thin helium films and on the properties of liquid helium confined to small pores. (auth)

29165 MODEL FOR THE FORMATION OF PERSISTENT MASS CURRENTS IN LIQUID HELIUM II. Bergmann, D. (Weiz-

mann Inst. of Science, Rehovoth, Israel). Phys. Rev., 157: 169-80(May 5, 1967).

A model to describe the creation of persistent mass currents in liquid helium II is described and its consequences are analyzed for an experiment where these currents are formed by slowly bringing to rest a rotating ring containing a condensed boson gas in equilibrium at T = 0°K. The ring is assumed to contain, besides the noninteracting boson gas, a large number of randomly distributed scatterers, which would presumably engender a normal viscosity at higher temperatures; thus the creation of supercurrents is not trivial. The container and scatterers are included in the dynamical system; this brings about an effective interaction between bosons, which is handled by the self-consistent-field method. With the help of additional approximations and numerical computations, the time-dependent process of creating the mass current is examined and it is concluded that it can indeed be formed under usual conditions. (auth)

29166 MEASUREMENTS OF THE VELOCITY OF SOUND IN ^{3}He AND ^{4}He GAS AT LOW TEMPERATURES WITH IMPLICATIONS FOR THE TEMPERATURE SCALE. Grimsrud, D. T.; Werntz, James H. Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 157: 181-90(May 5, 1967).

Measurements of the velocity of sound in ^{3}He and ^{4}He gas have been made at constant temperature as a function of pressure in the temperature range 1.2 to 3.8°K. The measurements, made using a fixed-frequency, variable-length resonant technique, have an uncertainty of approximately 0.07%. The results have been analyzed in terms of an expansion of the velocity of sound in powers of the pressure to determine the absolute temperature of the experimental system and the second virial coefficient of the gases in this temperature range. The calculations indicate that the T_{58} ^{4}He temperature scale may be 3 to 6 mdeg K lower than the absolute temperature scale. The results of the second-virial-coefficient calculations agree well with the best previous determinations taken from gas isotherm measurements. (auth)

29167 SHORT INTRODUCTION TO SUPERCONDUCTIVITY THEORY. Ferrell, R. A. (Univ. of Maryland, College Park). pp 107-212 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

The fundamentals of the theory of superconductivity are covered with emphasis on an exposition of the basic simplicity of the theory when regarded as a self-consistent field problem. By means of simplifying assumptions the many-body problem is reduced to a single-body problem. The Curie–Weiss theory of ferromagnetism, the free electron gas, and the Cooper instability are first treated. The remaining sections deal with reduction of the four-particle line graph, consequences of the phase of the order parameter, normal correlations, depairing agents, temperature dependence of the superconductivity energy gap, thermodynamics of superconductors, and properties of superconducting ground state. (L.B.S.)

29168 BASIC MANY-BODY CONCEPTS FROM A UNIFIED COLLECTIVE POINT OF VIEW. Carmi, G. (Yeshiva Univ., New York). pp 1-105 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

Some concepts basic to many-body problems are introduced and clarified by considering a simple system consisting of two masses connected by an ideal spring and moving in one dimension. In the dynamics of this system the connection between concepts such as collective modes, long-range correlations, symmetry breaking, stability regions in phase space, and the existence of different phases of matter are developed. The general theory of separation between collective and individual features in the dynamics of many-body systems is then discussed. To illustrate the behavior of more complex systems applications are made to an electron gas and towards a systematic theory of superconductivity. A discussion is then given of phase transitions in metals. (L.B.S.)

29169 LOCAL APPROXIMATION IN THE ELECTRODYNAMICS OF LONDON SUPERCONDUCTORS. Svidzinskii, A. V.; Slyusarev, V. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Dokl. Akad. Nauk SSSR, 172: 569-71(Jan. 21, 1967). (In Russian).

The authors present a simple method of obtaining the fundamental equations of a variant of superconductivity theory, which permits a direct generalization to include nonequilibrium current states. The theory is based on the use of two-time temperature Green's functions combined with a Fourier transform technique. The results reveal certain circumstances which are not dealt with in the standard theories of J. Bardeen (Rev. Mod. Phys., 34: 667 (1962)) and V. P. Galayko (Fiz. Metal. i Metalloved., 21: 496(1966)) with respect to the role of the gap in the spectrum of the elementary excitation and the possibility of observing gapless superconductivity in bulk superconductors. The present treatment yields directly relations for the thermodynamic critical field and for the Silsbee rule. (ATD)

29170 THE INFLUENCE OF JOULE'S HEAT UPON CHARACTERISTIC MAGNITUDES IN A CYLINDER WITH CURRENT IN THE INTERMEDIATE STATE. Freud, R. (Inst. for Low Temperatures and Structure Researches, Wroclaw). Phys. Status Solidi, 20: K151-3(Apr. 1, 1967).

A calculation was made of the temperature distribution along the radius in a cylinder with current in the intermediate state. Equations involving Joule's heat were derived and compared with experimental measurements. The temperature difference between the axis and the surface was determined to be less than 10^{-5}°K. It is concluded that the deviations in the distribution of the magnetic induction and the radius cannot be caused by Joule's heat in the domains of the normal phase, and that London's model of the intermediate state of a cylinder contradicts experiments for type-I superconductors. (D.L.C.)

29171 PENETRATION DEPTH IN TWO-BAND MODEL SUPERCONDUCTORS. Radhakrishnan, V. (Tata Inst. of Fundamental Research, Bombay). Phys. Status Solidi, 20: 783-9 (Apr. 1, 1967).

The experimental results of Maxfield and McLean for the variation of penetration depth $\lambda_L(T)$ with temperature for niobium cannot be explained in terms of the usual BCS model of superconductivity. It is shown that better agreement can be obtained on the basis of the two-band model, proposed by Suhl, Matthias, and Walker, for transition-element superconductors. (auth)

29172 TYPE-I SUPERCONDUCTIVITY IN MOLYBDENUM. French, R. A. (Oxford Univ.). Phys. Status Solidi, 21: K35-8 (May 1, 1967).

Equations to be used in calculating the Ginzburg–Landau (G–L) parameter κ_0 are discussed. The G–L parameter at T_c was calculated to be 0.33 ± 0.002 for pure Mo (type-I); at T = 0, 0.53. Possible weaknesses in the calculation are considered. It is concluded that a magnetization tail should appear on cooling from T_c, at about 0.55°K. (D.L.C.)

29173 ULTRASONICS AND PHONONS IN SUPERCONDUCTORS. de Gennes, P. G. (CNRS, Orsay, France). J. Phys. (Paris), Colloq., 28: Suppl., C1.169-76(Feb. 1967). (In French).

Some properties of elastic vibrations in superconductors are reviewed at an introductory level, including: the weaknesses of the changes in elastic moduli at the transition temperature T_c; the strong decrease in ultrasonic attenuation when T goes below T_c and the importance of coherence factors; and the various effects which may occur in the presence of vortices. Finally, the principle of tunneling experiments which measure the phonon frequency spectrum in superconductors is presented. (auth)

29174 SOME APPLICATIONS OF SUPERCONDUCITIVITY. Pozsgai, Imre (Lajos Kossuth Univ., Debrecen, Hungary). Fiz. Szemle, 17: 15-19(Jan. 1967). (In Hungarian).

Soon after the phenomenon of superconductivity was discovered, it was recognized that it may be applied to the construction of a magnet, in which the electric energy is not dissipated. However, it was found that beyond a certain critical field strength, the wire acquires normal conductivity. In 1931, a lead–bismuth alloy with a critical field strength of 10^5 G was developed; later, critical field strength values of 200 kG at 18°K were reached with special alloys, such as Nb_3Sn. Such strongly superconducting alloys are commercially available. The tantalum diode (cryotron) becomes 10^9 times less resistant at its critical temperature in liquid helium. A bistable multivibrator may be built, using the cryotron. Other applications include electric flux pumping. A three-phase motor was built with superconducting bearings. Use of a superconducting modulator makes it possible to build a high-sensitivity amplifier for low-temperature thermoelectric measurements and for the amplification of signals obtained by the Hall effect. (TTT)

29175 RESONANCE SCATTERING IN IMPURE SUPERCONDUCTORS. II. EFFECTS OF CORRELATION AND DEGENERACY. Zuckermann, M. J. (Univ. of Virginia, Charlottesville). Nuovo Cim. (10), 49B: 41-57(May 11, 1967).

A generalization of a previous paper dealing with dilute alloys of simple superconductors with transition metal impurities is presented. It has been shown recently that a model due to Anderson for such alloys does not lead to localized magnetic states on the impurities if correlation effects are included, if the bound d states on the impurities are nondegenerate. Anderson's model, so generalized, is reasonable for nonmagnetic resonance scattering even in the degenerate case. Then the decrease in the superconducting critical temperature for alloys due to nonmagnetic resonance scat-

tering is sharpest when kT ≫ Γ, $E_{\alpha\beta}$ for some values of $\alpha\beta$. Here $E_{\alpha\beta}$ ($\alpha = 0, \ldots, N$; $\beta = 0, 1, \ldots, N-1$) are the energies of the bound d levels due to splitting by intra-atomic Coulomb and exchange interactions and Γ is the broadening due to Anderson's s-d interaction. This result is unphysical since Γ ≪ U_{eff}, where U_{eff} is the effective intra-atomic Coulomb interaction. The region Γ ≫ kT is physical since it includes the nonmagnetic limit Γ ≫ U_{eff}. The decrease in T_c in this region due to nonmagnetic resonance scattering is complemented by the anisotropic and valence effects of Kadanoff and Markowitz due to the mean-free-path effect of the impurities. The results are compared with experiment and superconducting tunneling effects in such alloys are also considered. (auth)

29176 CONDENSATION FOR AN INTERACTING BOSON SYSTEM. Coniglio, A. (Istituto Nazionale di Fisica Nucleare, Naples); Marinaro, M. Nuovo Cim. (10), 48B: 249-61(Apr. 11, 1967).

An infinite system of interacting bosons at temperature T = 0 is studied by a first-order self-consistent method. It is shown that such system may exhibit condensation in single-particle states or in more-particle states. The condensation in one or the other state depends on the interaction potential. Then we analyze the existence or otherwise of the gap in the excitation spectrum making use of theorems valid for systems which exhibit a broken symmetry. (auth)

29177 ON THE CRITERIA FOR THE BEST BOGOLYUBOV QUASI PARTICLE. Smith, V. H. Jr. (Uppsala Univ.). Nuovo Cim. (10), 48B: 443-6(Apr. 11, 1967).

Starting points for treating a many-particle system has been the independent-particle model (IPM). To treat a many-particle system more adequately than afforded by the IPM description, the canonical transformation to quasi-particles (QP) of Bogolyubov was introduced. This QP model was traditionally determined by an energy-variation principle. However, one may analogously consider criteria for this model. (M.O.W.)

29178 ASYMMETRIC GROUND STATES IN INVARIANT MANY-BODY THEORIES. Leplae, L. (Univ., Naples, GNSM, Naples); Sen, R. N.; Umezawa, H. Contract AF 61(052)-826. Nuovo Cim. (10), 49B: 1-31(May 11, 1967).

The nature of asymmetric ground states in invariant theories is investigated in detail for the cases in which Coulomb-type interactions are absent from the original equations of interacting nonrelativistic fields. It is shown that such ground states can be created only by the Bose–Einstein condensation of massless Bose fields in the stationary states (thus requiring the presence of such fields). Energy differences are seen to be forbidden in observed symmetry multiplets. The considerations, predominantly algebraic, which lead to these results are shown to provide a good qualitative picture of the behavior of systems with asymmetric ground states. As illustrations, the examples of ferromagnetism, neutral superconductivity, and superfluidity are treated from the same unified viewpoint. (auth)

29179 ANISOTROPY IN TUNNELING DENSITY OF STATES IN PURE TYPE-II SUPERCONDUCTORS. Maki, Kazumi (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 18: 835-6 (May 15, 1967).

Explicit expressions are given for the anisotropic density of states in a pure type-II superconductor in a high-field region, which is experimentally accessible. (M.H.R.)

29180 RELAXATION AND RECOMBINATION TIMES OF QUASIPARTICLES IN SUPERCONDUCTING Al THIN FILMS. Miller, Barry I.; Dayem, Aly H. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett., 18: 1000-4(June 5, 1967).

It has been conjectured that an excited quasi particle of energy E in a superconductor decays via a two-step process. The first consists of a relaxation in time τ_T to energy Δ, where 2Δ is the energy gap of the superconductor. This process occurs primarily by emission of a phonon of energy E-Δ. The second step is recombination in time τ_R of two quasi particles at energy Δ to form a Cooper pair and is accompanied by the emission of a phonon of energy 2Δ. A method was developed for measuring τ_R and τ_T as a function of temperature and energy, respectively, in aluminum. It is also possible to measure the dependence of τ_R on quasi particle density at a given temperature and the energy profile of the excited quasi particles. Using these techniques it is easier to understand the quasi particle relation and recombination processes in superconductors. (M.H.R.)

29181 DIAMAGNETIC AND PARAMAGNETIC SURFACE CURRENTS INDUCED BY TEMPERATURE CHANGES IN TYPE-II SUPERCONDUCTORS IN STATIC MAGNETIC FIELDS. LeBlanc, M. A. R. (Aerospace Corp., Los Angeles); Griffiths, D. J.; Belanger, B. C. Phys. Rev. Lett., 18: 844-8(May 15, 1967).

Evidence is presented that a change in surface currents from critical paramagnetic to critical diamagnetic (or vice versa) is induced by a suitable increase (or decrease) of the temperature of a semireversible type-II superconductor immersed in a static magnetic field H < H_{c1}. (auth)

29182 EFFECTS OF FILM GEOMETRY ON SUPERCONDUCTIVE TUNNELING. Gillespie, C. J.; Rachinger, W. A. (Monash Univ., Clayton, Australia). J. Appl. Phys., 38: 2615-18 (May 1967).

The effect of exceeding the critical current in one film of a superconducting tunnel junction is examined. The position of the normal superconducting boundary is calculated for a simplified model, and the form of the current–voltage relation is discussed. Nonuniformity of the film is shown to cause anomalous characteristics observed in Pb/PbO/Al junctions. (auth)

29183 SUPERCONDUCTING HOMOGENEOUS InTl AND PbBi FILMS EVAPORATED FROM A SINGLE SOURCE. Kopf, L. (Bell Telephone Labs, Inc., Murray Hill, N. J.). Rev. Sci. Instrum., 38: 734-5(June 1967).

Techniques are described for the evaporation of homogeneous alloy films from a single source. InTl, a substance whose components have very different vapor pressures, and PbBi, whose components have more similar vapor pressures, were successfully deposited as thin films by these techniques. Comparisons of superconducting transition temperatures with published data confirm that the films are indeed homogeneous. (auth)

29184 THEORY OF RESONANCE PHENOMENA IN SUPERCONDUCTIVE TUNNELING. Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Tekh. Fiz., 37: 157-66(Jan. 1967). (In Russian).

A theory is presented of the alternating Josephson current in which certain nonlinear effects are taken into account. By taking into account the time variations of the magnetic field strength at the Josephson junction and the potential drop across it, a nonlinear differential equation is derived for the phase of the Josephson current. From an approximate asymptotic solution of this equation for appropriate boundary conditions there is obtained an equation for the amplitude of the Josephson current. The theory accounts for the appearance of steps on the current–voltage characteristic of a Josephson junction and indicates that the height of the steps first increases with increasing Q of the junction, passes through a maximum and decreases with further increase of Q. For very high Q values there should be two or more possible equilibrium currents. The conditions for the appearance of such multivalued current–voltage characteristics have not been realized experimentally. (auth)

29185 FIZIKA NIZKIKH TEMPERATUR. II. (Low-Temperature Physics. Volume II). Tsakadze, Dzh. S. (ed.). Tbilisi, USSR, Izdatel'stvo Metsniereba, 1966. 86p.

Six articles are included on the subjects of rotation of viscous superfluids, the nature of phase transformation in rotating liquid helium, relaxation processes related to the temperature changes in rotating helium II, elastic vortex resistance in transverse deformation, and reactor interchannel cryostat with remote control cooling. Properties of quantum vortices in helium II in conditions of postcritical oscillations and uniform rotation. (R.V.J.)

29186 TERMOELEKTRICHESKIE OKHLAZHDAYUSHCHIE PRIBORY. (Thermoelectric Refrigeration Instruments). Kolenko, E. A. Moscow and Leningrad, Izdatel'stvo Akademii Nauk SSSR, 1963. 192p.

The basic physics of thermoelectric refrigeration and the methods for the calculation and construction of thermorefrigerating devices are explained. A series of thermoelectric refrigeration devices manufactured in the USSR, their use in various areas of research, and the manufacturing processes are systematically described. The methods of heat removal from thermoelectric batteries and the characteristics of power supplies are considered in special chapters. (tr-auth)

Plasma and Thermonuclear Physics

Refer also to abstracts 29287 and 29850.

29187 (AED-C-03-06(Pt.1)(Vol.2)) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. Bibliography, Author Index, Subject Index. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1967. 126p. Dep.

A bibliography containing 291 articles on various aspects of plasma physics is presented. Author and subject indexes are included. (M.O.W.)

29188 (AED-C-03-07(Pt.1)(Vol.2)) DOCUMENTATION OF PLASMA PHYSICS. PART 1: EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. Bibliography, Author Index, Subject Index. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Apr. 1967. 140p. Dep.

A bibliography is presented of 302 papers on various aspects of plasma physics. Author and subject indexes are included. (M.O.W.)

29189 (NP-16788) BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS. No. 22. Brewer, L. (comp.) (California Univ., Berkeley. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). Mar. 31, 1967. 14p. NBS, Washington, D. C. Free.

A listing of 59 papers is presented dealing with spectroscopy in high-temperature chemistry. In addition, a listing of 54 papers dealing with reactions between gases and condensed phases is presented. (M.O.W.)

29190 (TID-23827) QUARTERLY PROGRESS REPORT NO. 85. Zimmermann, H. J.; Harvey, G. G.; Mason, S. J. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Apr. 15, 1967. Contract AT(30-1)-1842. 349p. Dep. CFSTI.

Separate abstracts were prepared for 6 of the included sections. (M.O.W.)

For abstracts of individual sections see: 28873, 29204, and 29225–29228.

29191 (NASA-TT-F-433) PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR FUSION. Sinel'nikov, K. D. Translation of papers Presented at the 4th Conference on Plasma Physics and Controlled Thermonuclear Fusion, Kharkov, USSR, May 1963. 478p. (TT-67-51369; IPST-Cat.-1818; CONF-630509). CFSTI.

Seventy-eight papers are presented on various aspects of the following research: (1) high-frequency properties of plasma, (2) plasma-beam interaction, (3) gas discharge, (4) plasma stability, (5) methods of diagnostics of plasmoids; plasma injectors, (6) interaction of plasma with magnetic fields; shock waves in plasma, (7) injection of plasma and beams of particles, (8) magnetic traps, (9) vacuum techniques; low-temperature properties of metals, and (10) plasma diagnostics. (M.O.W.)

29192 FIZIKA PLAZMY I PROBLEMY UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA. DOKLADY CHETVERTOI KONFERENTSII PO FIZIKE PLAZMY I PROBLEMAM UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA, MAI 1963 g. VYPUSK 4. (Plasma Physics and Problems of Controlled Thermonuclear Synthesis. Reports of the Fourth Conference on Plasma Physics and Problems of Controlled Thermonuclear Synthesis, May 1963. Volume 4). Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. 544p. (NASA-TT-F-433; TT-67-51369; IPST-Cat.-1818; CONF-630509).

This book was translated cover-to-cover as NASA-TT-F-433; for the NSA reference, see the Report Number Index. (M.O.W.)

29193 ADVANCES IN PLASMA DYNAMICS. Proceedings of the Sixth Biennial Gas Dynamics Symposium, Evanston, Illinois, August 25–27, 1965. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967. 337p. $15.00. (CONF-650813).

Separate abstracts were prepared for 11 of the 14 included papers. The remaining 3 papers appeared previously in NSA as 19: 43457, 20: 37986, and 20: 40292. (M.O.W.)

For abstracts of individual papers see: 29077, 29078, 29099–29102, 29194, 29205, and 29230–29232.

Confinement and Heating of Plasma

Refer also to abstracts 29007, 29151, and 29204.

29194 PARTICLE LOSSES IN A SIMULATED FUSION PLASMA. McBee, W. D.; Shepherd, L. T. (Sperry Rand Research Center, Sudbury, Mass.). pp 85-97 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

A parallel is drawn between hot, dense, thermonuclear plasmas and cold, thin, thermally generated plasmas in terms of certain dimensionless parameters which relate to configurational stability. Experiments are being planned to use this parallel in a study of proposed thermonuclear plasma stabilizing field configurations and microinstabilities, using a thermally generated alkali plasma laboratory facility. The characteristics of the thermally generated plasma system and the results of experiments relating to diagnostics, diffusion, and configurational stability are described. (auth)

29195 DRIFT OF A THETA-PINCH PLASMA DUE TO THE ASYMMETRY OF MAGNETIC FIELD. Takeda, Yasumasa; Kawakami, Ichiro (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 22: 892-900(Mar. 1967).

The effects of the 1% local magnetic field asymmetry on the confinement of a low-B($\cong 10^3$ Gauss/sec) theta pinch plasma were studied by means of high-speed photography. The plasma drifts radially toward the region where the strength of the magnetic field is minimum. The mean drift velocity is several $\times 10^5$ cm/sec. It decreases appreciably as the field strength at the instant of the crowbar lowers less than 0.5 of the maximum in a half-cycle. The outward acceleration in the early stage was found to be $\alpha = [2k(T_e + T_i)/m_i a\beta](b/B_0)$, by the magnetohydrodynamic model where b/B_0 is the degree of the field asymmetry and a is the radius of the plasma column. The dependences of the observed drift velocity on the time of the crowbar and on the initial pressure are explained according to the above formula. The 1% local field asymmetry gives a serious limitation on containment of a high-temperature plasma. (auth)

29196 ION COOLING IN A Q-DEVICE. Blau, F. P. (Institut fuer Plasmaphysik, Garching, Ger.); Guilino, E.; Hashmi, M.; D'Angelo, N. Phys. Fluids, 10: 1116-17(May 1967).

Preliminary results obtained by cooling the plasma ions through collisions with noble gas atoms are reported. The main effect appears to be a substantial increase of the plasma density. (auth)

29197 INFLUENCE OF DRIFT WAVES UPON TRANSVERSE DIFFUSION IN A FULLY IONIZED MAGNETOPLASMA. Josephy, K.; Eastlund, B. J.; Marshall, T. C. (Columbia Univ., New York). Phys. Fluids, 10: 1112-14(May 1967).

An experiment is reported which shows that drift waves in a low-density, fully ionized magnetoplasma are associated with an enhancement of radial particle flux which may be interpreted by a diffusion equation. (auth)

29198 APPROXIMATE SOLUTION OF THE DIFFUSION EQUATION OF THE POSITIVE COLUMN. Shaw, David Tai-Ko (State Univ. of New York, Buffalo). Phys. Fluids, 10: 1110-12 (May 1967).

Approximate solutions of the spatial distributions of charged particles as gas discharge plasmas have been obtained by a two-point Jacobi expansion method which matches smoothly the series solutions expanded in the interior region and sheath region. (auth)

29199 PLASMA CONFINING EFFECT OF HIGH FREQUENCY MULTIPOLE ELECTROMAGNETIC FIELD. Kondo, Hiromichi; Toshioka, Katsushi (Mitsubishi Electric Mfg. Co., Ltd., Japan). Denki Gakkai Zasshi, 86-8: 1361-9(Aug. 1966). (In Japanese).

The plasma-confining effect of the rf multipole electromagnetic field is discussed, on the basis of a single particle. For some field configurations, it is shown that the field becomes equivalent to the restoring potential field for the charged particles when the frequency is sufficiently high. The possibility is indicated that, using the field produced by superposition of two stationary multipole rf fields, such as is achieved by the axial current distribution at r = R, $i_z = I(\sin m\theta \sin \omega_1 t + \cos m\theta \sin \omega_2 t)$ where $\omega_1 \neq \omega_2$, $\omega_1 \sim \omega_2 > \omega_{min}$ and m = 1,2,3,....., a cylindrically coaxial potential field is obtained. This kind of potential field can be easily transformed to the toroidal configuration, where the points of lowest potential lie on a circle close to the axis of the torus. A deuterium plasma is taken as an example, the rf field which effectively confines the deuterons is related to the deuteron energy and the dimensions of the bottle. The possibility of plasma confinement is confirmed by some numerical calculations under the most pessimistic assumption that electrons in this case are not given any direct confining force from the field. It is made clear by small-scale experiments using a hydrogen-filled discharge tube that the effect of the rf field upon the plasma is dependent on the potential gradient of the field thus obtained, and the confining effect of the above multipole field is actually expected. (NSA of Japan)

29200 DIFFUSION OF A WEAKLY IONIZED HELIUM PLASMA IN A METAL CHAMBER IMMERSED IN A MAGNETIC FIELD. Takeda, S.; Minami, K.; Uno, T. (Nagoya Univ., Japan). Phys. Rev. Lett., 18: 829-30(May 15, 1967).

The diffusion in a plasma, produced by microwave breakdown, in helium gas contained in a metal chamber was observed experimentally. The chamber is immersed in a static magnetic field, and the gas pressure range used in the experiment goes from 0.2- to 1-mm Hg. The experimental results are not in agreement with the short-circuit theory proposed by Simon. (M.H.R.)

Diagnostics of Plasma

Refer also to abstract 29100.

29201 (INR-781/XVIII/PP) USE OF A MONOCHROMATOR FOR THE VELOCITY AND TEMPERATURE MEASUREMENTS IN A COAXIAL PLASMA ACCELERATOR. Kulinski, S.; Nowikowski, J.; Suckewer, S. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 26p. Dep.

The axial speeds of different groups of ions as a function of a delay time τ for two test gases, hydrogen and air, were measured in a coaxial plasma gun with the aid of monochromator. At least two plasmoids were observed: a slow one propagating with the speed of about 2×10^6 cm/sec and a fast one with the speed of about 5×10^6 cm/sec. The speeds of different ions were approximately equal for a given plasmoid. The qualitative discussion of the obtained results based on the single particle model of acceleration is given. It indicated that two groups of accelerated particles can emerge from the gun, one in which the energy of a particle is proportional to its mass and another one with the energy independent of the mass of a particle but proportional to its charge. (auth)

29202 (LRP-29/66) MESURE DES PROBABILITES DE TRANSITION DE QUELQUES RAIES DE C II ET C III. (Measurement of the Transition Probabilities of Some C II and C III Lines). Durand, J. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland)). Dec. 1966. 28p. (In French). Dep.

The measurement of the transition probabilities of C III and C II is described. This measurement is made in a dense plasma (3×10^{18} cm^{-3}) having a temperature between 2.5 and 4×10^4 °K. (auth)

29203 (NASA-TN-D-4003) RESONANT FREQUENCIES OF A DIELECTRIC SPHERE IMMERSED IN A WARM COLLISIONAL PLASMA. Wenger, Norman C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1967. 26p. CFSTI.

The resonant modes of a dielectric sphere immersed in a warm collisional plasma are determined for various electron densities, electron collision frequencies, and electron temperatures. It is found that variations in the electron density, collision frequency, and temperature cause sufficiently large changes in the resonant frequencies and damping factors of these modes so that a dielectric sphere may be useful as a plasma diagnostic tool. (auth)

29204 (TID-23827, pp 71-134) PLASMA PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

A wide-bandwidth Michelson interferometer was used to measure phase shifts caused by a repetitively pulsed plasma over the spectral range from $k = 1/\lambda = 8$ to 55 mc^{-1}. Descriptions are given of the method, equipment, and results of the measurements. Electron density measurements were also made with a narrow-band far-infrared spectrometer. A discussion is presented of this technique and results. Brief discussions are also presented on the following research topics: microwave scattering from warm plasma waves near the electron cyclotron frequency, nonlinear harmonic generation at plasma resonance, laser breakdown experiment, and microwave emission from n-type indium antimonide at 422 and 77°K. (M.O.W.)

29205 APPLICATION OF SPECTROSCOPIC METHODS FOR MEASUREMENTS OF PLASMA ELECTRON TEMPERATURE AND DENSITY. Ho, Chieh (Plasma Physics Group, New Brunswick, N. J.); Duffey, Dick. pp 281-300 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25-27, 1965. See CONF-650813.

Results from investigations of the method of estimating electron temperature by using the ratios of spectral line intensities of some impurity species and the method of measuring electron density by using the Stark-broadened Hβ line profile are reported. (auth)

29206 DETERMINATION OF ELECTRON DENSITY IN MAGNETOPLASMA WITH ELECTROSTATIC PROBE. Miyoshi, Syoichi (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Jap., 22: 915-21(Mar. 1967).

The effects of magnetic field, pressure, and discharge current on the saturation electron current flowing in a cylindrical probe are investigated by use of two methods: one is based on the probe characteristic of ion current and the other on the microwave measurement. Experiments are made in helium at pressures ranging from 0.3- to 1.6-mm Hg with electron density $10^{11} \sim 10^{12}$ cm^{-3} and $0 \sim 5000$ gauss of magnetic field strength. Results of experiments show that the sink region thickness around the probe perpendicular to the magnetic field is given by $V_e/(\omega_p^2 + \omega_B^2)^{1/2}$ where V_e is the thermal velocity of electron, and ω_p and ω_B are the angular frequencies of electron plasma and cyclotron respectively. Use of this region and the theory developed by Dote enables one to determine the numerical value of the electron density of magnetoplasma. The result obtained by using electron current characteristic of the probe with its axis parallel to the magnetic flux agrees well with the real density. The measurement on the probe perpendicular to the magnetic lines of force is also carried out. (auth)

29207 ION TEMPERATURE IN A PLASMA PRODUCED BY CONTACT IONIZATION. Hirschberg, J. G.; Hesser, J. E.; Hinnov, E.; Rynn, N. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Fluids, 10: 1114-16(May 1967).

Doppler ion kinetic energies in pure barium and barium-cesium mixtures were measured interferometrically in the Q-1 device. At low density, results correspond to temperatures considerably hotter than the electrons or end plates. Equality is approached towards higher densities. (auth)

29208 ELECTRICAL CONDUCTIVITY OF A PARTIALLY IONIZED GAS. Johnson, L. C. (Princeton Univ., N. J.). Phys. Fluids, 10: 1080-4(May 1967). (MATT-494).

Electron velocity distribution functions for a partially ionized gas in a weak, steady electric field are obtained by solving the Boltzmann-Fokker-Planck equation numerically. As in the case of a fully ionized gas, the electron-electron interactions in a partially ionized gas affect the velocity distribution function and, consequently, the electrical conductivity. Electrical conductivities are calculated for a variety of assumed electron-molecule collision frequencies. The results differ by only a few percent from those obtained using an approximation suggested by Frost. A simple procedure, requiring no numerical integrations, is given relating electron temperature to electrical conductivity for a partially ionized gas. (auth)

29209 WAVES AND NOISE IN A POSITIVE-COLUMN PLASMA AT LOW PRESSURE. Zaitsev, A. A.; Shvilkin, B. N. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 172: 565-8(Jan. 21, 1967). (In Russian).

This is a continuation of earlier work (Vestn. Mosk. Univ. Ser. III, No. 3, 1965 and earlier), dealing with propagation of electroacoustic waves in low-pressure plasmas (on the order of 10^{-2} mm Hg). The authors review a number of other papers dealing with the fluctuations and plasma stratification accompanying these waves, and describe the results of additional investigations of a discharge produced between a water-cooled hollow cylindrical cathode and a hollow movable anode in a uniform tube, in which the gas pressure ranged from 1 mm to ~0.03 mm. In all cases, with decreasing pressure, starting at ~0.1 mm Hg, characteristic noise appeared in the discharge, with a maximum intensity near 0.1 to 0.5 MHz, depending on the gas. In Ne and He, the noise was produced when moving striations were present in the positive column, and in the case of He they occurred in the absence of striation. In a Ne-He mixture, the positive column was either striated or not, depending on the mixture proportion. Noise spectrograms are presented, and it is shown that with increasing distance from the head of the column, the striation oscillations increase, and the noise component decreases. The noise also vanished when the electrodes were brought close enough together to make the positive column disappear. The fact that the fluctuations are maximal near the head of the positive column is taken as evidence that the noise is generated there, and is probably connected with ion-sound oscillations. An exact theoretical analysis is made difficult by the presence of an electron-accelerating field at the start of the positive column. (ATD)

29210 EXCITATION OF HELIUM-KRYPTON MIXTURE. Malakhov, V. P.; Moskalenko, V. F.; Ostapchenko, E. P.; Oreshak, O. N.; Stepanov, V. A. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 545-6(Apr. 1967). (In Russian).

In the dc discharge in the mixture of krypton with helium the electron concentration does not change markedly with the change of the partial pressure of helium under constant pressure of krypton and grows with the increase of the partial pressure of krypton under constant pressure of helium. Step-by-step excitation under the action of an electron impulse from the excited levels situated beneath may be considered as the main process of populating 3p and 2p levels of krypton. Step-by-step excitation cross section of 2p levels from 1s levels is 5×10 cm^2. (auth)

29211 PLASMA DIAGNOSTICS BY SPECTROSCOPIC METHODS. Robinson, David; Lenn, Peter D. (Electro-Optical Systems, Inc., Pasadena, Calif.). Appl. Opt., 6: 983-1000(June 1967).

Spectroscopic techniques for the measurement of plasma parameters are reviewed for a range of temperatures up to 10^{6}°K. Tables and figures of useful data have been prepared or have

been collected from the literature for ready application to experimental measurements. The problem of making spatially resolved intensity measurements in an optically thin axisymmetric plasma column is discussed. (auth)

29212 MEASUREMENT OF THE VELOCITIES OF PLASMA COMPONENTS BY MEANS OF HIGH-SPEED PHOTOGRAPHY IN MONOCHROMATIC LIGHT. Derevshchikov, V. A. Zh. Tekh. Fiz., 37: 315-21(Feb. 1967). (In Russian).

High-speed streak photographs were recorded in monochromatic light of the plasma jets issuing from a vacuum discharge between coaxial electrodes. The experiments were undertaken in order to determine the cause of the banded structure observed by other investigators in similar photographs recorded with white light and ascribed by some of the investigators to the successive ejection of different plasma bursts (microplasmoids), and by others to a helical structure of a single plasma jet. Bands recorded simultaneously with the light of different ionic species showed different numbers of bands differently distributed and with different slopes (indicating different velocities). From this it is concluded that the bands are not due to a spiral structure of a single plasma jet, but to the successive ejection of separate microplasmoids. It is suggested that the successive emission of plasmoids is due to repeated pinching of the discharge at the face of the central electrode. This hypothesis is supported by the fact that the end of the central electrode acquired a conical shape after a number of discharges. The plasma velocities measured by the present method are in good agreement with those measured by the Doppler shift technique. In addition to having the advantage of time and space resolution, the present method enables one to measure lower velocities than does the Doppler shift technique. (ATD)

29213 DIAGNOSIS OF THE PLASMA BURSTS FROM A COAXIAL PLASMA GUN BY MEANS OF A RESONATOR. Golovanivskii, K. S.; Dzherpetov, Kh. A. Zh. Tekh. Fiz., 37: 254-61 (Feb. 1967). (In Russian).

A device intended for reducing the electron density of a plasma burst from a coaxial plasma gun without significantly reducing the velocity or the degree of ionization of the plasma is discussed. The 2.7-cm-diameter outer electrode of the plasma gun was sealed directly to the 2.5-cm-diameter 110-cm-long glass plasma duct. The diameter of the plasma duct was reduced to 1.4 cm for a length of 0.3 cm at four different points; the first of these constrictions was 11.5 cm from the plasma gun and the successive constrictions were 3.5 cm apart. Each of these constrictions permitted only the axial portion of the plasma burst incident on it to pass, and the plasma expanded radially in the regions between the constrictions, the desired reduction in density was effected. The plasma guide passed through a $14.3 \times 14.3 \times 9$ cm parallelepiped resonator with copper walls and a Q of 8700, which was excited in the H_{101} mode with the aid of a coupling loop. The signal from a second coupling loop was detected and displayed on an oscilloscope. The passage of the plasma burst (which was much longer than the resonator) was recorded before and after it traversed the resonator with the aid of two photomultipliers mounted 34 and 47 cm from the plasma gun and two capacity pickups mounted 28.5 and 86.5 cm from the gun. The results of the measurements indicated that the electron density in the plasmas after they had traversed the four constrictions did not exceed 3×10^{10} cm^{-3}, whereas without the constrictions the electron density would drop to this level only after hundreds of microseconds. The resonator diagnostic technique employed in these experiments is discussed at some length and its advantages over the usual microwave cutoff technique are pointed out. (ATD)

29214 STARK BROADENING OF ISOLATED ION LINES IN A PLASMA. Cooper, J. (Univ. of Colorado, Boulder); Oertel, G. K. Phys. Rev. Lett., 18: 985-8(June 5, 1967).

Numerical calculations were carried out for virtually all lines for which experimental half-widths are now available. Agreement between theory and experiment for the present calculations (within the impact approximation) is claimed to be as good as for those of Griem. Some of the remaining discrepancies can be blamed on experimental errors, wrong line identification, or incompleteness of the tables of energy levels. Calculations using Griem's complete-degeneracy assumption but with the full-velocity integration (and the matrix elements for interacting states used here) have shown that the use of the mean thermal velocity $\bar{v}$ can introduce errors (mostly increasing the width) in excess of 30% in some cases. (M.H.R.)

29215 INFLUENCE OF ELECTRON CORRELATIONS ON A PLASMA-BROADENED LYMAN-ALPHA LINE. Smith, Earl W. (Univ. of Florida, Gainesville). Phys. Rev. Lett., 18: 990-4 (June 5, 1967).

The results of the correction of the ideal-gas approximation are presented. The correction of the relaxation theory for electron correlations altered the Lyman-α profile, in that the dip in the center of previous ideal-gas profiles has been removed and a closer agreement with the impact theory has been obtained. While the impact and relaxation theories agree rather well over most of the Lyman-α profile, apart from asymmetries, there is a significant difference in intensity at the line center. (M.H.R.)

29216 MEASUREMENT OF THE ELECTRON ENERGY DISTRIBUTION FUNCTION IN A NOISY PLASMA. Kagan, Yu. M.; Milenin, V. M.; Mitrofanov, N. K. (Leningrad State Univ.). Zh. Tekh. Fiz., 37: 127-30(Jan. 1967). (In Russian).

A modification of the balanced double probe technique for recording electron energy distribution functions in the presence of noise was used to determine the electron energy distribution functions in the positive columns of mercury vapor arc discharges containing different concentrations of argon or krypton. The modification of the balanced probe technique consisted in incorporation of the method for automatically recording the second derivative of the probe characteristic that has been described elsewhere. The hot-cathode arc discharges took place in a 70-cm-long 2.5-cm external-diameter tube containing mercury vapor at a pressure of 2.5×10^{-3}-mm Hg and argon or krypton at pressures up to 2-mm Hg. The discharge current was 200 mA. Twelve electron energy distributions are presented graphically and are compared with the Maxwell distribution. The electron distribution in the pure mercury vapor arc was Maxwellian, but in all the other cases the arc was rich in low-energy electrons and poor in high-energy electrons, compared with the Maxwell distribution for the same average electron energy. (ATD)

29217 ELECTRON ENERGY DISTRIBUTION IN A TORCH DISCHARGE. Tikhomirov, I. A.; Marusin, V. V. (Tomsk Polytechnic Inst., USSR). Zh. Tekh. Fiz., 37: 110-11(Jan. 1967). (In Russian).

Boltzmann's equation is employed to calculate the electron energy distribution in a high-pressure torch discharge. Among the simplifying assumptions employed in the calculation are the following: the velocity distribution of the ions and molecules is Maxwellian; the electron thermal velocities greatly exceed the directed velocity of the electrons; the effect of the diffusion term can be neglected; the effect of space charge is small; and an electron loses on the average only a small fraction of its energy in an inelastic collision. The last assumption is supported by experimental evidence. The collision integral is calculated. A closed expression is obtained for the electron energy distribution function. The distribution function is presented graphically for the specific case of a torch discharge in air at 760-mm Hg and 4000°K in an electric field of 300 V/cm. The present distribution peaks at a considerably higher energy than does the Maxwell distribution, but it falls off much more rapidly with increasing electron energy. (ATD)

29218 WING-SLOPE TECHNIQUES FOR THE ANALYSIS OF LANGMUIR-PROBE CHARACTERISTICS IN A LOW-DENSITY PLASMA. Bettinger, Richard T. (Univ. of Maryland, College Park). J. Appl. Phys., 38: 2523-7(May 1967).

The volt–ampere characteristics of Langmuir probes utilized in ionospheric investigations and employing ideal geometries (spherical or cylindrical) contain a considerable amount of information, much of which is not utilized in the usual analysis programs. The slope of the V–I curve for large accelerating potentials contain a substantial amount of information on mass density and temperature. Equations were developed for the current and its slope in this region for both of the above geometries and have been applied to a few typical situations. It is concluded that the usefulness of Langmuir-probe techniques may be appreciably improved by performing a "total analysis" on the available information. In some cases, measuring the slope directly will supply the same information with a substantial saving in experimental complexity. (auth)

Kinetics of Plasma

29219 (IPP–6/55) ON SOME PROPERTIES OF THE RADIATION NEAR THE HARMONICS OF THE ELECTRON GYRO-FREQUENCY IN PLASMAS. Croci, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1967. 16p. Dep.

The position of the lines emitted by an electron in a warm plasma is calculated. From this result it is deduced that the anomalously high emission in a plasma is due in some experiments to longitudinal waves, in some others to transverse waves. A mechanism for the coupling of the longitudinal (and transverse) waves which go adiabatically into vacuum is proposed. A reasonable number of suprathermal electrons can then account for the observed radiation. (auth)

29220 (IPP–6/56) NICHTLINEARE WECHSELWIRKUNG ELEKTROSTATISCHER WELLEN IM PLASMA IN HOEHEREN

NAEHERUNGEN ZUR QUASILINEAREN THEORIE. (Nonlinear Interaction of Electrostatic Plasma Waves in Higher Approximations for the Quasilinear Theory). Gratzl, Herbert (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1967. 85p. (In German). Dep.

The quasi-linear theory is often used to describe the asymptotic behaviour of a weakly unstable configuration (e.g., a two-stream instability). Altshul and Karpman extended the theory to include: (1) the influence of nonlinear wave processes, if the particle distribution function further changes adiabatically; or (2) strongly time-dependent distribution functions, if the nonlinear effects of (1) are further neglected (which can be important for small wave spectra). The results of (1) and (2) are now derived as approximations from more extensive expansions. Under the conditions of the quasi-linear theory corrections taking both processes (1 and 2) into account can be given. The corrections in case (2) are at least as important as in case (1), as long as the quasi-linear growth rate has not become considerably smaller than the initial value. The conservation of energy principle of the extended equations thus gained can in general only be proved if the quasilinear dispersion relation is also corrected. (auth)

29221 (MATT-538) ON THE NUMERICAL SOLUTION OF POISSON'S EQUATION. Smith, Craig G. (Princeton Univ., N. J. Plasma Physics Lab.). May 1967. Contract AT(30-1)-1238. 14p. (CONF-670419-1). Dep. CFSTI.

From Symposium on Computer Simulations of Plasma and Many Body Problems, Williamsburg, Va.

A fast technique is presented for the repeated numerical integration of Poisson's equation in a circular domain. The method is most appropriate for fluid or guiding-center simulations of plasma, for which the potential may be expected to be a smooth function of the spatial coordinates. The equation is first Fourier transformed with respect to the azimuthal coordinate. The solution of the resulting ordinary differential equations in the radial coordinate may be expressed in terms of integrals of the charge density with kernels which are powers of r. If the charge density is represented by a finite power series, then the expressions for potential, electric field, and energy are immediately obtained and are likewise finite power series. The idea thus is to numerically fit the data (charge density) to a representation and then to analytically integrate Poisson's equation and perform the subsequent differentiations and integrations to obtain the related quantities. The fit may be accomplished by the least-squares technique. Solving for the unknown coefficients need, in effect, be done only once; the coefficients are then repeatedly obtained by only matrix multiplication. Side conditions for the fit are discussed. (auth)

29222 (NASA-CR-72227) MICROWAVE DRIVEN MAGNETIC PLASMA ACCELERATOR STUDIES (CYCLOPS). Final Report, February 28, 1966–February 27, 1967. Crimi, G. F.; Eckert, A. C.; Miller, D. B. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Mar. 24, 1967. Contract NAS 3-8903. 150p.

A microwave-driven cyclotron resonance plasma acceleration device was investigated using argon, krypton, xenon, and mercury as propellants. Limited ranges of propellant flow rate, input power, and magnetic field strength were used. Overall efficiencies (including the 65% efficiency of the input polarizer) less than 10% were obtained for specific impulse values between 500 and 1500 sec. Power transfer efficiencies, however, approached 100% of the input power available in the right-hand component of the incident circularly polarized radiation. Beam diagnostics using Langmuir probes, cold gas mapping, rf mapping and ion energy analyses were performed in conjunction with an engine operating in a pulsed mode. Measurements of transverse electron energies at the position of cyclotron resonant absorption yielded energy values more than an order of magnitude lower than anticipated. The measured electron energies were, however, consistent with the low values of average ion energy measured by retarding potential techniques. The low values of average ion energy were also consistent with the measured thrust values. It is hypothesized that ionization and radiation limit the electron kinetic energy to low values, thus limiting the energy which is finally transferred to the ion. Thermalization by electron–electron collision was also identified as an additional loss mechanism. The use of light alkali metals, which have relatively few low-lying energy levels to excite, with the input power-to-mass ratio selected so as to limit the electron energies to less than the second ionization potential, is suggested. It is concluded, however, that the overall efficiency for such propellants would be less than 40%. (auth)

29223 (ORNL-4079) ELECTRON TEMPERATURE VARIATION INDUCED EFFECTS AND LANDAU DAMPING OF ION ACOUSTIC WAVES. Alexeff, I.; Jones, W. D.; Montgomery, David (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 19p. (ORNL-P-2827(Rev.)). Dep. CFSTI.

Ionic sound waves have been studied in a quiescent discharge-tube plasma. In this system, one can vary the electron temperature over the range 0.1 to 2.0 eV. Upon varying the electron temperature, the ionic sound waves have displayed the following three effects: (1) The velocity of the waves does show the predicted $T_e^{1/2}$ dependence. (2) At the lowest electron temperatures, the ion temperature contribution to the ion acoustic wave velocity becomes visible in the following fashion, $v = (kT_e + 3kT_i)^{1/2}m_i^{-1/2}$. (3) As the electron temperature decreases toward the ion temperature, a strong spatial damping of the ion waves is observed, which can be attributed to Landau damping of the waves by the ions. A second demonstration of controlled Landau damping of ion-acoustic waves has been made by adding a trace of helium to a xenon plasma. The most probable thermal velocity of the helium ions coincides with the ion-acoustic wave velocity in the predominantly xenon plasma, and strong Landau damping is expected. (auth)

29224 (SU-IPR-145) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 29, December 1, 1966–February 28, 1967. Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). Mar. 1967. Contract AT(04-3)-326. 49p. Dep. CFSTI.

Further research developments are reported on the following areas: ion wave propagation and positive column instabilities, electron beam probing of plasma-cyclotron echoes, beam-plasma interactions, and positive column resonances and propagation. (M.O.W.)

29225 (TID-23827, pp 135-40) GASEOUS ELECTRONICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

To account properly for the effect of electron–atom collisions on the propagation of waves in plasmas, it is necessary to utilize the Boltzmann collision integral. The treatment here utilizes the Boltzmann collision integral and assumes that the electrons collide with particles of much greater mass. The calculation determines the form of the dispersion relation for the electron plasma wave in the presence of electron–atom collisions. A brief discussion is presented. (M.O.W.)

29226 (TID-23827, pp 141-216) PLASMAS AND CONTROLLED NUCLEAR FUSION. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Various aspects of beam–plasma discharges are studied as follows: excitation of ion-cyclotron resonance, beam–plasma discharge, crossed-field beam–plasma experiments, beam–plasma interaction in a minimum-B field, anomalous millimeter microwave plasma density measurements, theory of beam–plasma interactions, dispersion relations for beam–plasma interactions, sheet models of the beam–plasma discharge, effect of essential singularities on stability criteria, motion of charged particles in magnetic mirror field in the presence of a radial time-variant electric field, experimental study of hollow-cathode discharge arc plasma, and magnetohydrodynamic wave propagation transverse to magnetic field. (M.O.W.)

29227 (TID-23827, pp 219-21) SPONTANEOUS RADIO-FREQUENCY EMISSION FROM HOT-ELECTRON PLASMAS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

An investigation was made of the instability occurring in the afterglow of a pulsed electron-cyclotron resonance discharge. This instability is characterized by bursts of radiation at frequencies near that of the rf heating field. Diagrams showing the radiated power as a function of time. (M.O.W.)

29228 (TID-23827, pp 223-9) INTERACTION OF LASER RADIATION WITH PLASMAS AND NONADIABATIC MOTION OF PARTICLES IN MAGNETIC FIELDS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Brief discussions are presented on experiments to measure the incoherent scattering of light from plasma, and electron diffusion in the helically trapped magnetic field of the M.I.T. stellarator. (M.O.W.)

29229 DISTRIBUTION OF THE MAGNETIC FIELD IN A COAXIAL PLASMA INJECTOR. Kovrov, P. E.; Morozov, A. I.; Tokarev, L. G.; Shchepkin, G. Ya. Dokl. Akad. Nauk SSSR, 172: 1305-8(1967). (In Russian).

It is shown that, in spite of prevalent opinions, the use of discharge pulses that are considerably longer than the time-of-flight results in plasmoids with good uniformity, since the longer injection pulses make it possible to distribute more advantageously the supply of matter to the injector and the discharge current over a larger surface, and obtain a plasma with uniform particle velocity. As a first step in proving this proposition, experimental data are reported on the current distribution in a quasi-stationary nitrogen plasma. The injector used was a coaxial system with cold elec-

trodes, fed from a capacitor bank producing square pulses up to 50 kiloamperes at 1.5 msec duration. The nitrogen supply was synchronized with the discharge. The distributions of the magnetic field and of the current were measured with probes and with a Rogowski loop. The results showed that when the central electrode of the injector was made negative, it was possible to transfer to the plasmoid as much as 40% of the initial current. The character of the current distribution, and particularly the strong influence of the polarity on the plasmoid current and on the structure of the outgoing plasmoid, is connected with the appearance of Hall currents, since a Hall current directed opposite the plasma motion causes deflection of the current lines. (ATD)

29230 NASA RESEARCH ON COLLECTIVE EFFECTS IN COLLISIONLESS PLASMAS. Thom, K. (National Aeronautics and Space Administration, Washington, D. C.). pp 63-83 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

Research on collective effects in collisionless plasmas in the laboratory is surveyed. Experimental verification of rigorous theory is achieved only in the case of the linearized Vlasov–Maxwell equations, in which Landau damping is demonstrated. (auth)

29231 MAGNETOAERODYNAMIC DRAG AND FLIGHT CONTROL. Ericson, W.; Maciulaitis, A.; Falco, M. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). pp 167-92 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

Magnetoaerodynamic drag and control forces available to a vehicle entering the earth's atmosphere are calculated. The entering vehicle is assumed to carry within its nose a magnet that can be oriented to any desired angular position relative to the axis of the vehicle. The drag and the control force are obtained from the braking interaction of the magnetic field with the ionized shock layer forcing the shock away from the body. The calculations include the effects of induced magnetic fields and nonscalar conductivities. The influence of the MHD drag on lifting and nonlifting trajectories is also considered. Comparisons with other investigations reported in the literature are made. (auth)

29232 STATUS OF MHD ACCELERATORS FOR TEST FACILITIES. Ring, Leon E. (ARO, Inc., Arnold Air Force Station, Tenn.). pp 193-233 of Advances in Plasma Dynamics. Anderson, Thomas P.; Springer, Robert W. (eds.). Evanston, Ill., Northwestern University Press, 1967.

From 6th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 25–27, 1965. See CONF-650813.

The fundamental limits of the various types of accelerators are reviewed and it is shown that the Faraday accelerator is best suited to operation at the high flow densities required. Estimates of expected accelerator performance and resulting facility performance for both pulsed and continuous operation are made and shown to be substantially higher than conventional aerodynamic and materials test facilities. Some of the phenomena and mechanisms involved are discussed. (auth)

29233 EXPERIMENTAL EVIDENCE OF THE NONLINEAR INTERACTION BETWEEN WAVES AND ELECTRONS OF A PLASMA. Frank, Rene (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 758-61(Mar. 6, 1967). (In French).

The interaction of plasma oscillations with the class of electrons whose velocity is such that the slope of the distribution function is positive was studied experimentally. The data show that deformation of the distribution function is connected with the amplitude increase of the plasma oscillations. Under certain conditions the quasi-linear theory can account for the results observed. (tr-auth)

29234 THEORY OF HARMONIC GENERATION IN A MICROWAVE GASEOUS PLASMA UNDER AN EXTERNAL MAGNETIC FIELD. Chiyoda, Katsuji (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 22: 910-15(Mar. 1967).

Theoretical studies are made of the harmonic generation in a high-frequency gaseous plasma under an external magnetic field on the basis of the Boltzmann equation. Expressions for the intensity of the higher harmonic radiations, especially of the second and the third, are derived and the results of their numerical calculation are graphically presented. These show that the higher harmonic radiations have sharp resonance peaks. The theory is compared with the experiment by Hill and Tetenbaum. (auth)

29235 ELECTRIC FIELD IN A STEADY COLLISION-DOMINATED THREE COMPONENTS PLASMA. Okuda, Takayoshi (Univ. of Nagoya, Japan). J. Phys. Soc. Jap., 22: 943-4 (Mar. 1967).

The electric field for sustaining collision-dominated partially ionized plasma has been evaluated simply from consideration of energy balance for electrons in the theory of positive column of the discharge. A general formulation is given of the problem of finding the expression for the electric field taking into consideration contribution of all constituents, i.e., the electron, ion, and neutral particle, on the basis of the hydrodynamic equations. (M.O.W.)

29236 STUDY OF THE ELECTRON RECOMBINATION OF H_2 IN AN AZIMUTHAL PINCH BY FOLLOWING THE EVOLUTION OF THE PROFILE OF THE RAYS WIDENED BY THE STARK EFFECT. Nguyen Van Trong (Societe d'Electronique et d'Automatisme, Courbevoie, France). Compt. Rend., Ser. A and B, 264: 770-3(Mar. 6, 1967). (In French).

A time-resolution spectrometer was used to study electron recombination in a H_2 plasma due to the azimuthal pinch. The electron density is obtained from the instantaneous profile of the $H\beta$ line widened by the Stark effect. (tr-auth)

29237 MAGNETIC-COMPRESSION WAVES IN COLLISIONLESS PLASMA: OBLIQUE AMBIENT MAGNETIC FIELD. Rossow, Vernon J. (Ames Research Center, Moffett Field, Calif.). Phys. Fluids, 10: 1056-62(May 1967).

Numerical analysis is made of the structure of one-dimensional unsteady magnetic compression waves propagating into collisionless plasmas when the ambient magnetic field is oblique to the wave direction. Integration of the equations of motion is carried out by dividing the flow field into discrete elements or slabs of plasma and following their motion on a digital computer. Results from these calculations show that both the sub- and supercritical solutions change continuously from one limiting situation to the other. A similarity rule is found for correlating the subcritical cases so that the two-parameter family of solutions in mass ratio and field angle are reduced to a single set. (auth)

29238 RELAXATION THEORY OF SPECTRAL LINE BROADENING IN PLASMAS. Smith, Earl W.; Hooper, C. F. Jr. (Univ. of Florida, Gainesville). Phys. Rev., 157: 126-37(May 5, 1967).

In this theory of spectral line broadening in plasmas, the radiation process is treated as the relaxation of an excited atom, weakly coupled to a thermal bath, to a state of lower energy. The theory emphasizes the Liouville-operator formalism, as developed by Zwanzig, and may be considered an extension of Fano's theory of pressure broadening in neutral gases. It may further be considered an illustration of a case in which an observable quantity can be expressed in terms of a well-defined correlation function, which can be evaluated without resorting to a microscopic analysis of the interactions. A comparison is made with the impact theories of Griem, Kolb, and Baranger; specifically, it is shown that the assumption of binary collisions and the impact approximation are not necessary in the relaxation theory. Of special importance are frequency-dependent "widths" and "shift" operators, which produce asymmetries in the intensity profile not predicted by the previous plasma-broadening theories. These asymmetries are illustrated in an application of the relaxation theory to the Lyman-α line. The line shape is calculated to second order in the weak-coupling potential, and a comparison is made with experimental observations of this line. (auth)

29239 MEASUREMENTS OF ELECTRON THERMAL DIFFUSIVITY IN AFTERGLOW PLASMAS. Nygaard, Kaare J. (Sperry Rand Research Center, Sudbury, Mass.). Contract AF19(628)-4183. Phys. Rev., 157: 138-45(May 5, 1967).

An experimental determination of the electron thermal diffusivity D_T in a room-temperature neon afterglow plasma is described. The measurements were made in the absence of a magnetic field and covered an electron density range from 10^9 to 10^{12} cm^{-3}. The principle of the experiment was to heat the electrons by a short microwave pulse, and then observe electron temperature transients at other locations within the plasma. The perturbations in the electron temperature were determined by taking advantage of the temperature sensitivity of the electroacoustic Tonks–Dattner resonances. For electron–ion collision frequencies ν_{ei} much larger than the electron–neutral collision frequency ν_{en}, the experimental data for D_T are inversely proportional to the electron density and agree closely with the transport theory of Spitzer and Härm. In the limit of the weakly ionized plasma, i.e., $\nu_{ei} \ll \nu_{en}$, the electron thermal diffusivity is independent of electron density and agrees within 25% with Shkarofsky's theory. (auth)

29240 COLLISION INTEGRAL FOR A PLASMA IN A STRONG MAGNETIC FIELD. Radin, S. (Aeronautical Research Associ-

ates of Princeton, Inc., N. J. Lehigh Univ., Bethlehem, Pa.); Kritz, A. H.; Sandri, G. Phys. Rev., 157: 150-2(May 5, 1967).

From the Bogoliubov–Born–Green–Kirkwood–Yvon hierarchy of statistical mechanics, the magnetic-field dependence of the collision integral to second order in field strength is derived. The field is sufficiently strong to make the Larmor frequency of the same order as the plasma frequency. The calculation is carried out explicitly for a Landau plasma (small-momentum-transfer regime). The simplicity of the result makes it particularly suitable for calculating transport coefficients for a plasma. (auth)

29241 MICROSCOPIC INTERPRETATION OF THE GENERALIZED HELMHOLTZ EQUATION. Schmid, Lawrence A. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids, 10: 1117-19(May 1967).

If a particle in a charged gas in adiabatic flow is pictured as a rotating cylinder whose volume and angular velocity are the reciprocal particle density and intrinsic vorticity, respectively, then the angular momentum of this cylinder has constant magnitude. (auth)

29242 EFFECT OF DETACHMENT PROCESSES ON PLASMA QUENCHING BY ELECTRONEGATIVE GASES. Ghosh, A. K.; Carswell, A. I.; Richard, C. (RCA Victor Research Labs., Montreal). Phys. Fluids, 10: 1100-6(May 1967).

The effect of detachment processes on plasma quenching by electronegative gases has been studied. An experimental method has been proposed to evaluate the ratio of detachment rate to the attachment rate and the method has been demonstrated using a nitrogen afterglow flow system seeded with the electronegative gases O_2, SF_6, and H_2O. An advantage of the flow system is that at low negative ion concentrations the electron losses resulting from diffusion and recombination are essentially the same before and after seeding. For oxygen the measured ratio of K_d/K_a is 3×10^{13} (by spectroscopic measurement) and 1.2×10^{14} (by probe measurement) which is in good agreement with existing literature values. The ratio of K_d/K_a for SF_6 is found to be 2×10^{-6}. (auth)

29243 ACCELERATION PROCESS IN THE HALL CURRENT DEVICE. Rosciszewski, Jan (Convair Div. General Dynamics, San Diego, Calif.). Phys. Fluids, 10: 1095-9(May 1967).

A simplified analytical model of the flow in a Hall current device is discussed. An acceleration to the sonic speed in the constant cross-sectional channel is assumed when radiation and the ionization process are taken into account. The supersonic expansion occurs in a diverging magnetic field which acts like a nozzle. (auth)

29244 LOW-ENERGY ELECTRON MOMENTUM TRANSFER COLLISIONS IN CESIUM PLASMAS. Nighan, William L. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Fluids, 10: 1085-94(May 1967).

An effective momentum transfer collision frequency for electrons in cesium plasmas has been determined from measurements of the electrical conductivity and plasma properties in a cesium arc column. The effective collision frequency was found to depend on electron temperature in the 2500 to 4500°K range and to be significantly dependent on degree of ionization for values of this parameter greater than about 3×10^{-4}, indicating a contribution from electron–ion collisions. Numerical evaluations of the velocity integral for the electrical conductivity, modified to include electron–ion as well as electron–atom momentum transfer collisions, have been carried out using many trial functions for the electron–cesium atom momentum transfer cross section. The electron–atom cross section which has given the best fit between the calculated and measured conductivity exhibits a Ramsauer-like minimum in the 0.25- to 0.55-eV range of electron energy. (auth)

29245 ACCELERATION OF INHOMOGENEOUS PLASMAS BY LASER LIGHT. Hora, H.; Pfirsch, D.; Schlueter, A. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 22a: 278-80(Feb. 1967). (In German).

When laser light interacts with a plasma a strongly anisotropic expansion of the plasma is observed, which is principally directed against the laser light. Equations were derived to show that a substantial acceleration occurs by a nonlinear interaction of the light wave with the inhomogeneities of the plasma. (J.S.R.)

29246 STUDY ON THE OPERATIONAL CHARACTERISTICS AND REPRODUCIBILITY CONDITIONS OF TOROIDAL DISCHARGES WITHOUT AXIAL MAGNETIC FIELD. Sinman, Sadrettin (Univ. of Istanbul). Istanbul Univ., Fen Fak. Mecmuasi, Seri C, 30: 177-252(July-Oct. 1965).

The operational characteristics and reproducibility conditions of toroidal devices with low and medium voltage gradient (4 to 30 volts/cm) were studied. This problem was considered in two phases. First, study was made on the discharge model made of a copper torus in order to improve the experimental technique and to see how this technique will be applied to problems involved in the gas discharge. Then experiments were continued with two pyrex tori of the same geometry but with different arrangements. In order to determine the optimum conditions for such devices studies were carried out on the electrical and discharge characteristics with respect to circuit and discharge parameters. In addition, the field configurations in the second pyrex were studied with the aid of magnetic probes. The experimental results (primary current, volts per turn, and total gas current) obtained for a constant energy of the capacitor bank were compared with theoretical considerations derived from the equivalent circuit of the system, and optimum constructional factors were discussed. The factors causing an increase in the total gas current were studied systematically under pressures between 30 and 100 μ Hg at constant bank energy level. Under standard experimental conditions and with the use of oscillograms obtained from magnetic probes employed in plotting field configurations, it was observed that the discharge was reproducible to 1.6 μsec under 250 μ Hg. The total plasma current corresponding to 50, 100, and 250 μ Hg was found to be reproducible for two periods. Under 250 μ Hg, it was determined with the aid of azimuthal field distributions and derived data [$J_x(r)$ and $P_m(r)$], that the plasma constricted during the first half-period of the electrical field, that the discharge rotated and the pinch was helical in form, and that the instability was of the m = 1 mode. (auth)

29247 INTERFEROMETRIC INVESTIGATIONS ON ELECTROMAGNETICALLY ACCELERATED SHOCK WAVES. II. Brinkschulte, H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 22a: 438-43(Apr. 1967). (In German).

The shock waves produced in T tubes were investigated with a Mach–Zehnder interferometer. The experiments were conducted in hydrogen at an initial pressure of 5 torr. A power crowbar arrangement was used to produce single current pulses. These caused single shock waves to occur with every discharge. Reproducible, nonsteady shock waves separated from the discharge plasma were observed at Mach numbers M < 15. By measuring the time dependence of the velocity of the shock front over the entire length of the tube (60 cm) it was found that the shock front behaves in accordance with the homology theory of V. Weizsäcker. From the interferograms it is also possible to determine (but only qualitatively) the drop in density immediately behind the front. As the density jump increases, this drop becomes steeper and steeper—again in agreement with the theory. Moreover, it was shown by side-on photographs taken at various distances from the electrodes that the shock front becomes plane once the shock wave has covered a path ten times longer than the tube diameter. (auth)

29248 SPECTRA OF THE LOW-FREQUENCY OSCILLATIONS OF VACUUM ARCS. Belensov, P. E.; Plyutto, A. A. Zh. Tekh. Fiz., 37: 300-6(Feb. 1967). (In Russian).

Noise spectra were obtained for Mg, Zn, Cd, and Bi arcs in vacuum over a frequency range from 0.02 to 30 MHz. The arc was struck in a vacuum of the order of 10^{-5} mm Hg between a plane cathode of the investigated metal and an annular anode. The oscillations of the arc current and in the signals from two probes mounted on the axis of the system (the perpendicular through the center of the cathode, which was also perpendicular to the plane of the anode and passed through its center) at some distance from the electrodes were observed with an oscilloscope and analyzed with a type S4-8 panoramic spectrum analyzer, the pass band of which was varied from 20 to 200 kHz depending on the experimental conditions. When the arc current was lower than a critical value the arc was unstable and tended to go out; under these conditions the noise spectrum was unreproducible and no detailed study of this regime was attempted. At higher currents the arc was stable and the noise was concentrated into the low-frequency region below 1 MHz. The total noise intensity decreased and the spectrum shifted toward the lower frequencies for an appreciable time (some seconds) after the arc was struck, and finally reached steady values which depended very little on the arc current. The noise spectrum recorded with the probe was relatively much weaker in the low frequency components than was the spectrum of the arc current fluctuations, and the maxi maximum in the probe spectrum occurred at a higher frequency than did that in the arc current spectrum. The oscillations in the signals from the two probes were rather strongly correlated, even when the probes were some distance apart, whereas the correlation between the probe signal and the arc current fluctuations was weak. Two mechanisms for the production of the oscillations are discussed, either of which appears capable of accounting for the experimental results and both of which may have been effective: the first mechanism is associated with relaxation phenomena tak-

ing place near the electrode, and the second, with the excitation in the plasma of ionic sound by electrons accelerated in the double layer near the cathode and the scattering of these waves by ions. (ATD)

29249 MEASUREMENT OF THE HALL CURRENT IN THE HOMOPOLAR DEVICE. Drobyshevskii, E. M.; Rozov, S. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 322-6(Feb. 1967). (In Russian).

In the homopolar device the plasma is formed in the annular space between two coaxial cylindrical electrodes in the presence of an axial magnetic field; the Hall current accordingly flows azimuthally. The Hall currents were measured by recording the changes produced by them in the axial magnetic field, the effects of the 0.01% fluctuations of the magnet current being compensated. The measurements were made under different conditions in hydrogen, argon, krypton, and air plasmas. It was found that the azimuthal current was directly proportional to the radial current, was almost independent of the gas pressure, decreased slowly with increasing magnetic field strength, and was usually greater when the inner electrode was the anode than when it was the cathode. The experimental data did not satisfy the relation between the ratio of the aximuthal to the radial current, the ratio of the electron Larmor frequency to the electron-collision frequency, and the ratio of the ion Larmor frequency to the ion collision frequency deduced from the equation given by Cowling (Proc. Roy. Soc., A183: 433(1945)) for the electric conductivity of the plasma. It is suggested that the discrepancy may be due to turbulence in the plasma. Some agreement is shown between the present data and an equation deduced for a turbulent plasma by Yoshikawa and Rose (Phys. Fluids, 5: 334(1962)), but the data are not adequate to support a definite conclusion. (ATD)

29250 INVESTIGATION OF AXIAL AND RADIAL INHOMOGENEITIES IN A HOLLOW CATHODE HELIUM DISCHARGE. Borodin, V. S.; Gerasimov, G. N.; Kagan, Yu. M. (Leningrad State Univ.). Zh. Tekh. Fiz., 37: 392-5(Feb. 1967). (In Russian).

The electron density, electron energy distribution, and electric field strength at different points in 25, 40, and 100 mA discharges in helium at pressures from 0.5 to 5 mm Hg between a 2-cm-diameter 5- or 10-cm-long hollow cylindrical cathode and a coaxial anode have been measured with a 0.06-mm-diameter 5-mm-long probe that was mounted parallel to the axis and could be moved in both the radial and axial directions, and the results are presented graphically. The electron concentration was more nearly uniformly distributed throughout the volume of the hollow cathode and the axial component of the electric field was lower in the discharges at the higher helium pressures than in those at the lower pressures. The electron energy distribution function recorded at the end of the cathode in the low-pressure discharges had two peaks; the higher-energy peak (at about 12 eV in the 40-mA discharge at 0.5-mm Hg in the 10-cm cathode) was not present farther within the cathode, and in the higher-pressure discharges it was not present even near the end of the cathode. The radial intensity distributions of five different helium lines (including both singlets and triplets) were also measured. These distributions are presented graphically and are discussed briefly. (ATD)

29251 THERMAL RADIATION OF CERTAIN CONVEX PLASMA BODIES. I. Nazarenko, L. A.; Yakimenko, I. P. (Kharkov State Univ.). Zh. Tekh. Fiz., 37: 234-41(Feb. 1967). (In Russian).

The general theory of fluctuations was used to calculate the thermal radiation in the microwave region of a uniform plasma sphere in equilibrium in free space. The calculations were undertaken because of their usefulness in plasma diagnostics and for the interpretation of radioastronomy data. To calculate the electromagnetic field within the plasma, the hydrodynamic equations were used to describe the plasma and neglect the gas kinetic pressure and the motions of the ions. This approach does not enable one to calculate the specifically plasma resonances, but it gives a rather accurate account of the ordinary electromagnetic resonances. An expression is obtained for the radiated power as a function of frequency in the form of an infinite series, the separate terms of which represent the contributions of electric and magnetic multipoles of different orders. It is found that in the Rayleigh limit (wavelength long compared with the radius of the sphere), magnetic multipole radiation predominates in the case of a highly conducting sphere, whereas the contribution of magnetic multipole radiation is negligible in the case of a poorly conducting sphere. In this limit the maximum radiation occurs at the resonant resonance frequency of $L/3^{1/2}$, where L is the Langmuir frequency of the plasma. By measuring the frequency and width of the resonance and the intensity of the radiation one can determine the electron density, collision frequency, and temperature of the plasma (even when the radius of the plasma sphere is not small). Because the absorption of the plasma is taken into account in the calculations it is not necessary to perform special experiments to measure the absorption. (ATD)

29252 MOTION OF PLASMOID IN A CURVED MAGNETIC FIELD. Voitsenya, V. S.; Gorbanyuk, A. G.; Onishchenko, I. N.; Safronov, B. G.; Khizhnyak, N. A.; Shkoda, V. V. Zh. Tekh. Fiz., 37: 262-73(Feb. 1967). (In Russian).

The effect produced by electron–ion collisions on the plasma motion along a curved magnetic field and the motion of fast and dense plasmoids in toroidal magnetic fields were investigated. The experiments were conducted with plasmoids produced by coaxial and conical sources. It was found that the behavior of plasma in both cases was essentially different. The fast plasma of the coaxial source, after passing the magnetic field of a toroidal solenoid, was noticeably purified. A drift of the plasma as a whole was observed, the drift rate increasing with the increase in the velocity of the directed motion. In the case of the slow plasma of the conical source, only the head part of the stream ($v \sim 9 \times 10^6$ cm/sec, $n \lesssim 10^{12}$ cm^{-3}) moved in the above manner, while the motion of the the main plasma was unstable. The following conclusions were made: The transmission and purification of plasma from impurities of heavy ions take place in the case of a dense plasma when $4\pi n_0 Mc^2/H_0^2 \gg 1$ if the curvature and magnetic field intensity are selected so that $M\nu_0 c/eH_0 < d_0/2$ for hydrogen ions and $M\nu_0 c/ZeH_0 > d_0/2$ for impurity ions. The presence of electron–ion collisions causes an additional plasma drift. Therefore, in addition to the above-mentioned conditions $\mu L/\tau_{ei}\nu_0 \ll 1$ should be also satisfied. L is the length of the curved section of the magnetic field and τ_{ei} is the time of electron–ion collisions. A fast plasmoid in which the energy of the H^+ ions is of the order of 3 keV and the density of the H^+ ions is higher than 10^{13} cm^{-3} is purified considerably. An impurity of ~30% prior to the toroidal magnetic field was reduced to ~5% after passage of the field. The velocity spread of impurity ions prevents a more effective purification of the plasmoids. (ATD)

29253 TESTS OF A PULSED PLASMA ACCELERATOR OF RAIL GEOMETRY. Balagurov, A. Ya.; Ershov, A. G.; Levtov, V. L.; Leskov, L. V.; Petrov, A. M.; Savichev, V. V.; Chivilev, V. A. Zh. Tekh. Fiz., 37: 274-9(Feb. 1967). (In Russian).

An experimental study was made of the formation and acceleration of plasma bunches in a rail-type electrodynamic accelerator. Various methods were used to measure its basic parameters (plasma energy momentum, temperature, velocity, and composition). The rails were parallel, aluminum-alloy electrodes 3 cm in diameter and 35 cm long. The distance between axes of the electrodes was 8 cm in one series of investigations and 10 cm in the other. The accelerator was mounted in an evacuated (~10^{-5} mm Hg) container. A signal opened a valve, which permitted injection of ≈0.1 mg of air into the container; a second signal, 0.1 to 0.6 msec later, triggered the discharge of a 200-μf, 3-kV capacitor. The plasma discharge lasted about 20 μsec, the current reaching a maximum of 35,000 A at a rate of 1.2×10^{10} A/sec. The accelerator power efficiency was ≈22%, with only one-half of the energy stored in the capacitor going into the discharge. Use of a low-inductance capacitor led to a two-fold increase in the electrical efficiency of the circuit. The plasma momentum obtained was 550 dyne·cm (as measured with a ballistic pendulum calorimeter), which corresponds to a maximum velocity of 5 to 6×10^6 cm/sec and a plasma energy of 185 J. High-speed photography (2.5×10^6 frames/sec) and spectral analysis were used to study the nature of the discharge and the structure of the accelerated bunch. On the basis of the Doppler effect, the plasma temperature was estimated at ≈200,000°K, its density at ≈$5(10^{16})$ particle/cm^3, and its velocity 6 to 7×10^6 cm/sec, with the acceleration process being the same as in the case of a partially filled gas accelerator. In accordance with the magnetic pressure topology, the plasma pinch had a Σ-shaped form, with an unstable lagging edge. (ATD)

29254 ACCELERATION OF A PLASMA WITH AN UNINTERRUPTED HALL CURRENT. Zharinov, A. V.; Popov, Yu. S. Zh. Tekh. Fiz., 37: 294-9(Feb. 1967). (In Russian).

It is assumed that the accelerator is much shorter than the ion Larmor radius and that the reciprocal of the electron Larmor frequency is much shorter than the electron momentum relaxation time. The mathematical treatment is not given for the axially symmetric case, however, but for the plane case when the magnetic field is in the z direction, the electric field is in the $-x$ direction, and the electrons drift in the y direction of a rectangular coordinate system x, y, z. It is also assumed in the calculations that the ions move in the direction of the electric field, that the magnetic field due to the Hall current is weak compared with the external magnetic field, that the electric field vanishes at the output, and that the electron temperature is everywhere proportional to the ratio of the potential to the anode potential. Under these assumptions, the potential distribution and some other characteris-

tics of the system are calculated. Potential distributions for different values of the proportionality constant determining the electron temperature in terms of the potential are presented graphically. (ATD)

29255 ELECTROMAGNETIC WAVE PROPAGATION IN A WEAKLY IONIZED PLASMA. III. De Barbieri, O.; Franchi, P.; Orefice, A. (Univ., Milan, CNR, Milan). Nuovo Cim. (10), 48B: 394-408(Apr. 11, 1967).

The conductivity of a plasma with an arbitrary ionization ratio is evaluated, in presence of a constant and uniform magnetic field. The calculation method is a generalization of the one employed in the preceding work. (auth)

29256 ELECTROMAGNETIC WAVE PROPAGATION IN A WEAKLY IONIZED PLASMA. II. De Barbieri, O.; Maroli, C.; Orefice, A. (Univ., Milan). Nuovo Cim. (10), 48B: 378-93 (Apr. 11, 1967).

A general formula for the high-frequency conductivity of a partially ionized plasma is evaluated. This result embodies, in suitable limiting cases, the well-known expressions of the conductivity for a Lorentz plasma and for a fully ionized plasma. With the aid of this formula the range of validity of the usual expression of the conductivity of a Lorentz plasma was established. (auth)

29257 INTENSE MAGNETIC FIELDS AND SHOCK WAVE PROPAGATION. Masani, A.; Ferrari, A.; Martini, A. (Osservatorio Astronomico, Milan. Istituto di Fisica Generale, Turin). Nuovo Cim. (10), 48B: 421-4(Apr. 11, 1967).

The influence of a magnetic field on the phenomenology of shock waves propagating through very hot and dense plasmas is analyzed, relative to interpretation of phenomena connected with collapsed stars. (M.H.R.)

29258 KINETIC THEORY OF PLASMAS: PLASMA-RADIATION INTERACTION. Peyraud, Jean (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. B, 264: 931-4(Mar. 20, 1967). (In French).

A Boltzmann term was used to represent the plasma-radiation interaction by Compton effect. This term is developed by the powers of the perturbation caused by the motion of the electrons of the first and second order. The results are applied to the study of the evolution of the motion and to determination of the energy transfers. A definition of the kinetic temperature of a radiation not in equilibrium was introduced. (tr-auth)

29259 KINETIC EQUATION FOR A COMPLETELY IONIZED PLASMA. Dobbertin, Rolf (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 264: 963-6(Mar. 29, 1967). (In French).

The kinetic equation obtained previously by establishing a relation between the reduced probability densities $F_1(x_1,t)$ and $F_2(x_1, x_2,t)$ was applied to the study of a completely ionized plasma not in equilibrium. (J.S.R.)

29260 STUDY OF THE OPTIMIZATION OF THE POSITION OF THE INJECTION INTO HIGH-FREQUENCY PLASMA ACCELERATORS. Canobbio, Ernesto; Collet, Roland (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 264: 967-70 (Mar. 29, 1967). (In French).

The effect of the position of the injection point of an electron–ion pair into a high-frequency plasma accelerator on the asymptotic value of the magnetic moment μ_a was studied. An injection position that makes μ_a maximum was determined, and a mean value of μ_a when this optimum position is withdrawn, is given. (tr-auth)

29261 THEORY OF NONLINEAR OSCILLATIONS OF ELECTRON PLASMA. Gel'fand, I. M.; Zueva, N. M.; Imshennik, V. S.; Lokutsievskii, O. V.; Ryaben'kii, V. S.; Khazin, L. G. Zh. Vychisl. Mat. Mat. Fiz., 7: 322-47(Mar.-Apr. 1967). (In Russian).

A one-dimensional electrostatic oscillation in a rarefied collisionless plasma was analyzed. A maximum case $e\phi \gg kT = 0$ of damping of a plane sinusoidal wave in cold collisionless electron plasma was studied. The oscillation process was studied, considering three independent parameters: the plasma density n_0, the initial perturbation wave length $\lambda = 2\pi/k$, and the a wave amplitude in the initial distribution $f(x, u, t)/_{t=0} = \delta(u - a \sin kx)$ of electron density in the cold plasma phase space (x, u). The qualitative and quantitative properties of oscillations at supercritical amplitudes were resolved by two numerical methods. The adequacy of the methods was proved by correlating them with the universally known analytical solution for pre-critical amplitudes $a < a_0$. Results of a series of calculations revealed a strong damping of large-amplitude waves, with the decrement of damping rapidly rising with the increase of the wave amplitude. The damping process became practically aperiodical with the amplitude, exceeding the critical by a factor of $2(a \sim 2a_0)$ and the oscillation energy changed into turbulent motion. The electron distribution function showed wide spread, and acceleration of a certain portion of particles was observed. In addition to the problem on sinusoidal wave damping, $f(x, u, 0) = \delta(u - a \sin kx)$ in a cold plasma was resolved for the problem of a motion appearing in a more general type $f(x, u, 0 = \Sigma f_{i\delta}(u - b_i - a \sin kx)$ where a, b_i, and f_i are constant but i denotes two or several values. Detailed calculations based on the equation of characteristics and on the discrete plasma model used for solving the problem of monochromatic waves and the problem with two-velocity initial distribution are included. (R.V.J.)

29262 PARAMETRIC COUPLING BETWEEN ION AND ELECTRON WAVES. Sjoelund, A.; Stenflo, L. (Royal Inst. of Tech., Stockholm). J. Appl. Phys., 38: 2676-8(May 1967).

Parametric coupling between ion and electron waves is studied by means of coupled-mode theory. The coupling coefficients are determined. Two examples of parametric coupling are considered. One results in amplifying waves and the other in an absolute instability. The growth rate is calculated. (auth)

29263 DECAY INSTABILITY OF A WAVE WITH A RANDOMLY VARYING PHASE. Zaslavskii, G. M.; Zakharov, V. E. Zh. Tekh. Fiz., 37: 10-12(Jan. 1967). (In Russian).

By "decay instability" is understood the tendency of a wave of finite amplitude propagating in a nonlinear dispersive medium to decay into two waves, the sum of whose frequencies is close to the frequency of the initial wave. The time constant for such decay has been calculated in terms of the properties of the medium for a wave of constant amplitude and phase. The time constant is calculated for a wave of constant amplitude whose phase undergoes sudden changes at times that are distributed according to Poisson's law. The calculation was undertaken because the nonlinear interactions of waves lead to random fluctuations of their phases, and these fluctuations can affect the decay instability. The problem is similar to but not identical with the problem of the relaxation of a two-level system under the influence of a random phase external field. A cubic equation is derived whose only positive root is the decay constant (the reciprocal of the time constant). This root is discussed briefly for the special case when the sum of the frequencies of the secondary waves is exactly equal to the frequency of the primary wave. When the phase changes are large and/or the probability per unit time that a phase change occur is high, the decay constant is very small compared with its value for a wave with constant phase and amplitude. (ATD)

29264 ABSORPTION OF ELECTROMAGNETIC WAVES IN A PLASMA NEAR HARMONICS OF THE ELECTRON CYCLOTRON FREQUENCY. Anisimov, A. I.; Vinogradov, N. I.; Golant, V. E.; Pakhomov, L. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 202-5(Jan. 1967). (In Russian).

The absorption of microwaves in plasmas produced by the microwave field itself was investigated. The plasmas were produced in 1.7-cm-diameter 20-cm-long sealed glass tubes having conical ends and containing hydrogen at pressures from 0.002- to 0.05-mm Hg. Microwave power in the 3-cm-wavelength range was supplied in 250-W pulses of about 1-sec duration through a 3-cm-diameter cylindrical waveguide that encompassed about half of the discharge tube. A longitudinal magnetic field with a 50-msec rise time and a nearly exponential decay was provided. The microwave power reflected by the plasma and the intensity of the radiation from the plasma in the 3500- to 7500-Å range were recorded during the decay of the magnetic field (the microwave power transmitted by the plasma was too small to measure). The reflected power passed through sharp minima when the magnetic field strength passed through such values that a harmonic of the electron cyclotron frequency in the plasma was equal to the frequency of the microwave field. The resonance absorption did not decrease rapidly with increasing order to the harmonic, and strong absorption was observed at the 20-th harmonic (when the magnetic field strength was 170 Oe); the discharge ceased and the plasma decayed when the magnetic field strength dropped below 170 Oe. The intensity of the optical radiation from the plasma decreased sharply at the resonances. Microwave probe measurements at 30 kMHz showed that the plasma density remained above the critical value of 10^{12} cm^{-3} during the entire discharge, and therefore that the Langmuir frequency was higher than the applied microwave frequency. It is concluded that resonance absorption of electromagnetic waves takes place in a plasma at harmonics of the electron cyclotron frequency provided the Langmuir frequency is higher than the frequency of the absorbed wave, and that the absorption does not weaken rapidly with increasing harmonic order. It is suggested that the resonance absorption may be due to transformation of the transverse electromagnetic wave into a longitudinal plasma wave, which is strongly absorbed. (ATD)

29265 PLASMA NOISE RADIATION ASSOCIATED WITH WAVE TRANSFORMATION. Piliya, A. D. (Ioffe Inst. of Phys-

ics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 199-202(Jan. 1967). (In Russian).

The effect of the transformation of waves on the radiation of noise by a plasma is discussed. It is assumed that the density and other characteristics of the plasma depend only on one coordinate z of a rectangular coordinate system x, y, z and that the wave that undergoes transformation is plane and polarized outside the plasma. The contribution of the transformation of the wave to the random currents in the plasma is calculated. It is shown that when the wave transformation coefficient A is large the intensity of radiation from the plasma is $AI_0/2$, where I_0 is the intensity of radiation from a black body having the radiation temperature T_r. (ATD)

29266 REFLEX DISCHARGE IN A WEAK MAGNETIC FIELD. Kucherenko, E. T.; Saenko, V. A. (Kiev State Univ.). Zh. Tekh. Fiz., 37: 112-17(Jan. 1967). (In Russian).

Investigations were made of the static characteristics of cold cathode reflex discharges in helium, argon, and air in magnetic fields up to 300 Oe, at pressures of the order of 10^{-3}-mm Hg, and at anode potentials of the order of 1000 V. The investigation was undertaken because the mechanism of the reflex discharge is less well understood under these technically important conditions than under conditions of arc discharge. The discharges took place between disk-shaped cathodes within a 3- or 5-cm-diameter cylindrical anode. One cathode was movable within the cylindrical anode, by varying the position of this cathode it was possible to vary the length of the discharge space from 6 to 15 cm. There was a 3-mm-diameter opening in the center of one of the cathodes, through which ions or electrons could be extracted. The ion, electron, and anode currents were measured as functions of the magnetic field strength and the distance between the cathodes, and the results are presented graphically and discussed. All three currents were found to exhibit a quasiperiodic dependence on both the magnetic field strength and the intercathode distance, particularly at low magnetic field strengths. The ion and electron currents were maximum when the anode current was minimum. Short discharges with the intercathode distance approximately equal to the anode diameter were found to yield larger ion currents than longer discharges. It is concluded that the periodic dependence of the ion, electron, and anode currents on the magnetic field strength is due to a specific feature of the motion of the fast electrons in the discharge region. (ATD)

29267 THE LOW-PRESSURE COLD CATHODE PENNING DISCHARGE. Popov, Yu. S. Zh. Tekh. Fiz., 37: 118-26(Jan. 1967). (In Russian).

A theoretical treatment is given of the cold-cathode low-pressure reflex discharge, based on the assumption that classical diffusion of electrons takes place transversely to the magnetic field. Relations are derived between the discharge current, the anode potential, the magnetic field strength, the electron concentration, the potential distribution, the thickness of the space charge layer at the anode, and other features of the system. The calculations are first performed for a plane anode and are subsequently modified for the case of cylindrical geometry. Special attention is given to the discharge in the Penning cell and in the inverted magnetron. The results are compared with experimental findings of many different investigators, and considerable agreement is shown. The theory in its original form, however, does not account for the frequently observed escape along the magnetic lines of force to the cathode of electrons that have acquired energies in excess of the energy that they could acquire by falling through the applied potential difference. This longitudinal escape of electrons can be incorporated into the theory by introducing a special term for that purpose, but to achieve quantitative agreement with experiment it is necessary to substitute values of the electron ionization frequency and the product of that frequency by the electron momentum relaxation time that are an order of magnitude smaller than are required in the absence of longitudinal escape and collisions of electrons with neutral particles. (ATD)

29268 RECOMBINATION OF ELECTRONS AND ATOMIC IONS. Smirnov, B. M. Zh. Tekh. Fiz., 37: 92-7(Jan. 1967). (In Russian).

The development and improvement of an earlier proposed method for determining the recombination coefficient for electrons in a plasma are described. With the aid of the Smoluchowski equation for the electron transition probability it is shown that the recombination coefficient is equal to the reciprocal of the mean time for an initially free test electron to recombine and reach the ground state provided that this time is much longer than the time characteristic of transitions between free states and that there are bound states, the probability of finding the electron in which is much less than that of finding it in a free state. Approximate expressions are introduced for the electron transition probabilities and there is obtained an equation for the mean recombination time of a free electron, which determines the electron–ion recombination coefficient. This equation is valid in the case of impact–radiative recombination provided the plasma is ideal for all degrees of ionization. (ATD)

29269 DIVERGENCE OF AN ELECTRON–ION BUNCH. Smirnov, V. M. (Moscow Engineering-Physics Inst.). Zh. Tekh. Fiz., 37: 102-9(Jan. 1967). (In Russian).

A theoretical investigation was made of the divergence of an electron–ion bunch in vacuum. Three special cases of divergence were analyzed under the assumption of a constancy of the cross-over density of the noncompensated charge at any given instant. The ions were assumed to be "cold." First, a strict kinetic solution was obtained, on the basis of a selected electron distribution function. A hydrodynamic description of the electron behavior was then given. Both solutions indicate that electrons, losing energy, pinch toward the center of the bunch, and the density of the noncompensated charge with a crossover constant in time decreases (in time) faster than the particle density. Further, an "isothermic" solution is discussed for purposes of comparison under the assumption that no energy is lost by the electrons in the process of divergence of the bunch. The solution shows that the density of the noncompensated charge in this case decreases in time at the same rate as the particle density. The space charge remains evenly distributed over the bunch cross section. Ion velocity increases indefinitely as the result of the energy being conveyed to the electrons from the heating. The behavior of the ion shell of the bunch is described as diverging as the result of the transition of the ions from the compensated part into the shell. (ATD)

29270 INVESTIGATION OF A MAGNETIC SYSTEM FOR CUTTING OFF A PLASMA JET. Andryukhina, E. D.; Shpigel, I. S. Zh. Tekh. Fiz., 37: 33-9(Jan. 1967). (In Russian).

A "magnetic gate" for cutting off a plasma jet is described. With the aid of this gate one can admit to the experimental equipment only the leading portion of the burst from a plasma gun, cutting off the tail of the burst which usually contains most of the impurities. (TSS)

29271 MOTION OF SYMMETRIC CURRENT-CARRYING PLASMOIDS ALONG THE AXIS OF A SEMI-INFINITE CIRCULAR WAVEGUIDE. Igushkin, L. P.; Urazakov, E. I. Zh. Tekh. Fiz., 37: 40-9(Jan. 1967). (In Russian).

The Wiener–Hopf method was used to calculate the field both inside and outside of a semi-infinite waveguide of circular cross section and finite wall conductivity, due to the uniform motion along its axis of an axially symmetric distribution of current. The calculations are valid for relativistic velocities. The case of infinite waveguide wall conductivity is first treated. The current induced in the waveguide wall is expanded in a Fourier integral with respect to both space and time and explicit expressions are obtained for the auxiliary functions employed in the Wiener–Hopf method to factor the kernel of the integral equations expressing the boundary conditions. In the treatment of the finite waveguide wall conductivity case it is assumed that the skin depth (the penetration depth of the induced current into the waveguide wall) is small compared with the waveguide radius and the wavelength of the radiated energy and approximate expressions for the auxiliary functions for the factorization of the boundary condition integral equation kernel are obtained from those for the infinite wall conductivity case with the aid of the assumption that the changes in these functions due to the finite wall conductivity are small. Expressions are derived for the vector potential of the field both inside and outside the waveguide, for the radiated energy, and for the force on the moving current distribution. These expressions are somewhat simplified for the special case when the current distribution can be treated as a magnetic dipole with its axis parallel to the waveguide axis. Numerical computations showed that a dipole moving at 0.1% of the velocity of light along the axis of a 0.1 m radius waveguide and inducing a current of 1 A in the waveguide wall radiates an energy of 2.72×10^{-10} J on leaving the waveguide if the waveguide wall conductivity is infinite, and an energy of 2.93×10^{-10} J if the waveguide wall conductivity is 5.5×10^7 mho/m. (ATD)

29272 MEASUREMENT OF PLASMA POLARIZATION IN A CLOSED MAGNETIC SYSTEM. Il'enko, B. P.; Lats'ko, E. M.; Zalkind, V. M. Zh. Tekh. Fiz., 37: 50-5(Jan. 1967). (In Russian).

Earlier investigations were continued on the polarization of plasmas injected transversely into magnetic fields. In the present experiments plasmas with densities not less than 10^{13} cm^{-3} and velocities of 2×10^6 cm/sec, produced by conical plasma guns, were injected transversely into an 8.3-cm-diameter stainless steel vacuum chamber having the racetrack configuration with 30-cm-long straight sections and 35-cm-long semicircular sections in which there was maintained a longitudinal magnetic field of strength up to 360 kA/m, and the electric fields and potentials in the plas-

mas were measured at different positions with probes. The plasmas were injected in the plane of the racetrack either from inside or from outside the racetrack at the center of a straight section, or from outside the racetrack at the center of a semicircular section. When the plasma was injected at the center of a straight section, electric polarization of the plasma in the direction perpendicular to the plane of the racetrack V × B polarization was observed, this polarization increased with increasing strength of the longitudinal magnetic field and was retained by the plasma as it moved around the track. No centrifugal polarization of the plasma due to its motion around the semicircular sections was detected. When the plasma was injected at the center of a semicircular section neither centrifugal polarization nor V × B polarization was observed, but the plasma became longitudinally polarized as it moved around the track. (ATD)

29273 BOUNDED PLASMA STREAM IN A MAGNETIC FIELD. Sinel'nikov, K. D.; Rutkevich, B. N. Zh. Tekh. Fiz., 37: 56-66(Jan. 1967). (In Russian).

The polarization phenomena accompanying the entrance of a bounded plasma stream into a transverse magnetic field is discussed. A uniform magnetic field parallel to the axis of a rectangular Cartesian coordinate system x, y, z is assumed to fill the half-space $x > 0$ and a plasma stream of finite thickness in the y direction and moving in the positive x direction with constant velocity is assumed to enter the field at the plane $x = 0$. The problem is first treated for a "plasma" in which the positively and negatively charged particles have the same mass, and subsequently for a real plasma in which the ions are more massive than the electrons. The calculations in this section are based on the equations of motion of the electrons and ions in the crossed electric and magnetic fields. Effects of collisions are at first neglected, and it is assumed throughout that the x component of the velocity of the plasma in the magnetic field is nearly equal to its value in the region $x < 0$. This assumption is justified by the large value of the dielectric constant of the plasma in the magnetic field. In the case of a real plasma there is not only a transverse polarization in the y direction, but also a longitudinal polarization in the x direction which arises because the forward motion of the ions is less hindered by the transverse magnetic field than is that of the electrons. Expressions are derived for the polarization field and for the motion of the two components of the plasma. It is found that the drift velocity of the plasma along the x axis differs very little from the initial velocity of the plasma before it enters the field. A dissipative term proportional to the difference between the ion and electron velocities is added to the equations of motion and the damping of the plasma oscillations is discussed. The conservation of energy and momentum is discussed and some of the results previously obtained from the equations of motion are derived anew from the conservation laws. The case of a plasma stream with two components having different initial velocities is treated. With the aid of the results of this section one can treat the case of a plasma with an arbitrary distribution of initial velocities in the x direction. Finally, the effect on the motion of the plasma of the presence of electrodes in the planes $y = 0$ and $y = a$, short circuited through a resistance R, is discussed. If $R = 0$, the plasma does not penetrate into the field. (ATD)

29274 FORMATION OF A LOW-PRESSURE ARC DISCHARGE IN A MAGNETIC FIELD. Vlasov, M. A. Zr. Tekh. Fiz., 37: 67-71(Jan. 1967). (In Russian).

An investigation was made of the transition to the quasi-stationary state of low-pressure arc discharges from a 1-cm-diameter hot cathode in a 7.8-cm-diameter 40-cm-long chamber in the presence of a magnetic field. The discharges took place in hydrogen or nitrogen at pressures from 4×10^{-4} to 6×10^{-3} mm Hg. The anode potential was 100 V and the anode current was of the order of 150 mA. To facilitate investigation of the transition to the quasi-stationary state, the discharge was interrupted by a 2-msec positive pulse to the cathode. The behavior of the plasma was investigated with Langmuir probes and a plasmascope. At high pressures and in weak magnetic fields the transition to the quasistationary state was smooth; in other cases the transition was accompanied by instability that was manifested in oscillations of the ion saturation current and the appearance of plasma jets that rotated in the direction of the electron Larmor rotation. In still stronger magnetic fields drift instability was observed in the stationary regime and there appeared plasma jets that rotated in the direction of the ion Larmor rotation. Explanations are offered for the observed phenomena. (ATD)

29275 EMISSION CHARACTERISTICS FROM PLASMA VACUUM SPARKS. Suladze, K. V.; Plyutto, A. A. Zh. Tekh. Fiz., 37: 72-8(Jan. 1967). (In Russian).

Experimental data on the formation and stability of high-current electron pulsed bunches and some effects of their characteristics on current takeoff from plasma cathodes are presented. A spark discharge was used as the plasma source. The experimental setup is described and an investigation was made of the current takeoff values as a function of accelerating voltage, parameters of the arrangement, and diaphragm diameter. Electron current densities of 100 to 250 Amp/cm^2 were obtained from an emitting surface of 5 to 7 cm^2 in 10^{-6} sec pulses with a total current up to 10^3 Amp. Two stages in the current takeoff were observed. In the first stage, the current increases with the plasma density and is independent of voltage across the accelerating gap. The current pause ensues when the directed velocity of the electrons exceeds the ion "sound barrier," in which case the plasma enters a new state. The second stage is characterized by high current takeoff values and a step-wise increase in these values. The characteristic time for the development of instability in the experiments was 10^{-8} to 10^{-9} sec. The observed divergence of the bunch was considerably less than had been theoretically anticipated. The crossover density distribution, which was higher at the axis than on the periphery, confirmed the compensation of the space charge of the bunch by the ions and the pinch effect. Both of these effects counteract divergence and make it possible to protract bunches up to 100 Amp over a considerable distance. On the whole, the process of current takeoff from plasma differs from the takeoff from thermocathodes and the Childs-Langmuir relationships are therefore not applicable. (ATD)

29276 EQUILIBRIUM CONFIGURATIONS OF UNIFORMLY ACCELERATED AXIALLY SYMMETRIC PLASMAS. Morozov, A. I. Zh. Tekh. Fiz., 37: 79-84(Jan. 1967). (In Russian).

The uniform acceleration in a coaxial accelerator of an axially symmetric plasma under such conditions that the plasma configuration does not change during the acceleration and the plasma does not come in contact with the electrodes is discussed. Such conditions cannot be obtained if the magnetic field is purely azimuthal, but they are possible when the magnetic field has both radial and longitudinal components. The calculations are performed for a rail type accelerator, but the results can be applied to a coaxial accelerator. The equations of motion together with the boundary conditions specifying the desired conditions (the plasma configuration to remain constant and the plasma not to come into contact with the electrodes) give rise to an involved nonlinear Sturm–Liouville problem that does not always have a solution. However, a special case is found for which the solution can be obtained, and it is shown that the required conditions can be met. Special design of the electrodes is required to accommodate the longitudinal electric field that accompanies the required magnetic field configuration. (ATD)

29277 CYCLOTRON RESONANCE IN A COLD ROTATING PLASMA. Dolgopolov, V. V. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 37: 23-7(Jan. 1967). (In Russian).

The absorption by a cold rotating plasma cylinder in radial electric and longitudinal magnetic fields of energy from an electromagnetic wave propagating both longitudinally and azimuthally and having a frequency close to the ion Larmor frequency is discussed. The resonance condition is derived from equations of motion in which the effects of collisions are neglected. The resonance frequency differs from the ion Larmor frequency by a term that depends on the rotational frequency (angular velocity) of the plasma and, unless the plasma rotates as a solid, resonance cannot simultaneously obtain through the entire body of the plasma, but only in a cylindrical shell. Dissipative terms proportional to the ion collision frequency k are introduced into the equations in order to calculate the rate of absorption of energy. It is shown that if k is sufficiently high the energy absorption rate of a rotating plasma at the resonance frequency is greater than the rate at frequencies far from resonance by a factor of approximately $f^2/k(k + r)$, where f is the frequency of the external electromagnetic field and r is the plasma rotation frequency in the resonance shell, and that the energy absorption rate at resonance of a nonrotating plasma is higher than that of a rotating plasma by a factor of approximately $(k + r)/k$. (ATD)

29278 RADIATION FROM CURRENT SOURCES IN AN ISOTROPIC PLASMA. Connolly, Denis J.; Tanenbaum, B. Samuel (Case Inst. of Tech., Cleveland). J. Appl. Phys., 38: 2557-62 (May 1967).

Using a three-fluid model, wave equations are developed for the disturbances due to current sources in a partly ionized gas. The formal solutions to the wave equations are obtained for an elementary current source. The power radiated from the source is given in terms of these solutions and, for the special case in which the electrons are much hotter than the other two constituents, the radiated power is determined in detail. (auth)

29279 PROCEEDINGS OF THE FIFTH INTERNATIONAL SYMPOSIUM ON RAREFIED GAS DYNAMICS, VOLUMES 1 AND 2, UNIVERSITY OF OXFORD, ENGLAND, 1966. Brundin, C. L.

(ed.). Advances in Applied Mechanics, Suppl. 4. London, Academic Press, 1967. 1743p. £7 8s. per Vol. (CONF-660709).

The Conference included about 100 papers. The papers are reproduced under the following sectional headings: gas–surface interactions, kinetic theory, transition flow, experimental methods, ionospheric aerodynamics. Each section is introduced by a "state-of-the-art" review paper. Separate abstracts were prepared for 17 of these papers. (UK)

For abstracts of individual papers see: 29003–29010, 29149–29151, and 29280–29285.

29280 CAPABILITIES OF THE COLD-ION APPROXIMATION IN COLLISIONLESS PLASMA FLOWS. Lam, S. H. (Princeton Univ., N. J.). pp 1603-22 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

Using the cold-ion approximation and assuming an unspecified relation between the electron density and the local electrostatic potential, the governing equation for the flow of a collisionless plasma is derived. It is shown that a first-order wave front analysis yields Boussinesq's equation. The behavior of the solutions for a steady one-dimensional ion stream tube of known area variation is discussed in some detail. It is shown that if Boltzmann's electron density formula is used, highly oscillatory (spatially) solutions are obtained under certain boundary conditions. If a self-consistent electron density distribution is used, the same boundary conditions yield generally smooth solutions. (auth)

29281 TEST-PARTICLE RELAXATION IN AN ELECTRON GAS DESCRIBED BY THE FOKKER–PLANCK KINETIC EQUATION. Ong, R. S. B. (Oxford Univ. United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 1623-38 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The approach to equilibrium of test electrons injected into an electron plasma in thermal equilibrium is investigated. In particular, the establishment of a Maxwellian distribution for the test particles as a result of like particle (electron–electron) collisions is followed. The linearized Fokker–Planck kinetic equation is used to describe this process. As a consequence of the continuous spectrum of eigenvalues of the collision operator, the decay to equilibrium of the test particles distribution function is not uniformly exponential; there exist various distinct stages of relaxation. These are exhibited and discussed. (auth)

29282 CHERENKOV RADIATION FROM FAST CHARGED PARTICLES IN ISOTROPIC PLASMA. Frood, D. G. H. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). pp 1639-56 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

Some unusual aspects associated with Doppler shifts of high-frequency radio waves reflected from artificial satellites, as reported by Kraus (1965), are discussed. The evidence indicates (to Kraus) that very fast disturbances are moving away from the satellite in all directions, and it is postulated that these "satellite-induced" disturbances could be Alfvén waves or bunches of fast electrons (plasmoids). Another possibility, which might ultimately help to account for these Doppler shifts, is that the satellite is emitting Cherenkov type electromagnetic radiation. This possibility is discussed. (UK)

29283 DISCRETE MODEL OF MEDIUM IN A PROBLEM ON RAREFIED PLASMA STREAM INTERACTION WITH A CHARGED BODY. Maslennikov, M. V.; Sigov, Y. S. (Steklov Mathematical Inst., Moscow). pp 1657-70 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The space experiments carried out with the help of rockets and artificial satellites have posed the problem of the interaction of a rapidly moving body with rarefied plasma. Theoretical studies of the detailed structure of the disturbance zone in the body's neighborhood are complicated by the non-linearity of the collective interaction of particles with the electromagnetic field in this zone, and by the lack of information for a qualitative description of the processes of absorption and origination of particles on the body's surface. In these conditions it is quite justifiable to construct approximate models, which preserve the main effects to the greatest possible extent, and to submit them for theoretical study. A detailed review of the various approaches to the problem has already been given. It is noted in this paper that the natural dimensionless parameters forming the basis of various theoretical approximations are the ratio of the characteristic size of the body R to the Debye length $D = (kT_e/4\pi n_0\epsilon^2)^{1/2}$ and the relative value of the potential on the body, $\psi_\sigma = e\varphi_\sigma/kT_e$, where ϵ is the electron charge, k the Boltzmann constant, and T_e the electron temperature. The use of computation methods allows a quantitative picture of the disturbance zone to be obtained. One of these methods is that of discrete modeling of rarefied plasma. A short description is given of the computational procedure used, together with several characteristic examples. (UK)

29284 COLLISIONLESS PLASMA FLOW AROUND A CONDUCTING SPHERE IN A MAGNETIC FIELD. Shea, J. J. (Cosmic, Inc., Washington, D. C.). pp 1671-86 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The equations describing collisionless plasma flow around a conducting sphere in a uniform magnetic field are stated rigorously. The conditions, valid for an ionospheric satellite, that (i) the vehicle speed is large compared to the ion thermal speed and small compared to the electron thermal speed, and (ii) the vehicle surface acts as a pure sink for charged particles are shown to lead naturally to a zero-order approximation, wherein the ion acceleration is due solely to the ambient magnetic field. The nonlinear, asymmetric, three-dimensional zero-order problem is stated precisely, and solved numerically for a set of typical conditions. Three-dimensional distributions of charged particle density, electrostatic potential, and electric field around the vehicle are presented and discussed. (auth)

29285 ELECTRODYNAMIC WAKE IN A RAREFIED PLASMA. Liu, V. C.; Jew, H. (Univ. of Michigan, Ann Arbor). pp 1703-16 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

A self-consistent theory of the distribution of charged particles and electric potential in the wake of a conducting body moving rapidly in a rarefied plasma is presented. The size of the body, which is negatively charged, is much larger than the Debye shielding length and smaller than the mean free path of the charged particles. The velocity of the body is large compared with the thermal velocity of ions but small compared with that of electrons. The analysis is restricted to the steady state solution in which the cause and effect of space charges are rigorously taken into account. The moving body is assumed spherical, but the method of approach is not limited by the geometry of the body. Numerical results of particle density and electrical potential are presented. The significance of the results to satellite–ionosphere interactions is discussed. (auth)

29286 ELECTRONS, IONS, AND WAVES. SELECTED WORKS OF WILLIAM PHELPS ALLIS. Brown, Sanborn C. (ed.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 450p. $20.00.

A collection of 22 papers is presented which deals with the following areas: electrons and their interactions with atoms, diffusion and mobility, motion of electrons and ions, microwave discharges, waves and oscillations, plasma properties, and special types of discharges. (M.O.W.)

Production of Plasma

29287 (COO–1695-1) DIAMAGNETISM OF AN ELECTRON CYCLOTRON RESONANCE PLASMA. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). Apr. 1967. Contract AT(11-1)-1695. 5p. (CONF-661115-3). DTIE.

From 8th Annual Meeting, American Physical Society, Division of Plasma Physics, Boston, Mass.

An experimental arrangement for production and diagnostics of an electron cyclotron resonance helium plasma using microwaves is briefly discussed. (M.O.W.)

29288 GAS DISCHARGE AS A SOURCE OF INCOHERENT RADIATION AT MILLIMETER AND SUB-MILLIMETER WAVELENGTHS. Hart, P. A. H. Philips Res. Rep., 22: 77-109(Apr. 1967).

The short-wave limit for the radiation emitted by a source using the plasma of the positive column of a gas discharge as a radiant medium has been considered by means of the Kirchhoff–Planck relation. In principle, because the radiation temperature of such a plasma is 10,000 to 30,000°K, sources can be built for any wavelength longer than a few tenths of a micron. "White"-noise sources characterized by single-mode operation are conceivable for any wavelength longer than 6.5–2.3 microns. Actually it appears to be very difficult at wavelengths shorter than about 100 microns to provide a sufficiently long optical path without introducing prohibitive parasitic losses at the same time. The structure examined

is a copper waveguide of circular cross section, having a diameter of 6 to 20 mm and perfectly smooth walls. The plasma which is assumed to fill the waveguide completely, provides a loss of L = 2.8 to 31 dB m^{-1} at 1-mm wavelength as has been calculated from simple theory. Although some attention is paid to other rare gases, the discussion is mainly concerned with neon since its high radiation temperature is about 18,000°K. It is expected that a source like this can be useful as a spectroscopy source since its radiation temperature is higher than that of the HP mercury-vapor lamp which has a radiation temperature of 2000 to 6000°K. A source of 18,000°K can radiate into a complete hemisphere a power of 4.7×10^{-7} watt/cm^2 output area at 1-mm wavelength and 4.7×10^{-4} watt/cm^2 at 0.1-mm wavelength; the bandwidth assumed is 1%. An optical system having 90° field of view receives half of these powers. (auth)

29289 PLASMA PRODUCTION BY FOCUSING OF A LASER BEAM ON A THIN TARGET. Bruneteau, J.; Fabre, E.; Salet, C.; Vasseur, P. (Ecole Polytechnique, Paris). Phys. Lett., 24A: 687-8(June 5, 1967). (In French).

A plasma is produced by the irradiation of a thin target with a laser beam. Observations are made on the light behind the target. It is noticed that with a foil of 0.05-μ thickness most of the laser beam is absorbed. (auth)

29290 APPLICATION OF THE θ-PINCH EFFECT FOR GENERATION OF STRONG SHOCK WAVES. Mucha, Z. (Inst. of Fundamental Technical Problems, Polish Academy of Sciences). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 1-7(1967).

Electromagnetic shock tubes may be classified into two types: electrode and electrodeless tubes. In order to establish a comparison of the suitability of both these types, the following characteristics were considered: velocity of the generated shock wave, purity of gas behind the shock wave, and possibility of application of the existing measurement methods. The results of the comparisons are discussed. (M.O.W.)

29291 DEVELOPMENT OF THE MOTT–SMITH METHOD FOR INVESTIGATING THE STRUCTURE OF SHOCK WAVES IN BINARY MIXTURES. Pataraya, A. D. Zh. Tekh. Fiz., 37: 28-32(Jan. 1967). (In Russian).

Generalized Mott–Smith functions were used to calculate the structure of a shock wave in a binary gas mixture containing only a small proportion of the minority component. The problem was treated separately for the two cases when the ratio m of the molecular weight of the majority component to that of the minority component is much greater than unity or is less than unity. The forces between the gas molecules were assumed to be inversely proportional to the 5-th power of the distance, and the distribution function for the minority component was assumed to be the sum of one or two Mott–Smith functions and a second or third function. The results were obtained in closed form in the first nonvanishing order of a perturbation theory based on the smallness of the ratio of the concentrations of the two gas components. Some numerical results for argon–helium mixtures are tabulated and compared with the corresponding results of Oberai. An approximate analytic solution was also obtained for the problem, solved numerically with the aid of generalized Mott–Smith functions by Salwen et al., of the structure of a shock wave in a one-component gas. A tabular comparison of the analytic formula with the numerical solution shows agreement within a few percent over a range of Mach numbers from 1.01 to 100. (ATD)

Stability of Plasma

29292 (IPPCZ–48) STRONG TURBULENCE OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Kopecky, V.; Vaclavik, J. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). Jan. 1966. 24p. Dep.

Instability of the drift-dissipative type, of a weakly ionized nonisothermal plasma in crossed electric and magnetic fields has been studied in the quasi-classical approximation for two cases: (a) $\Omega_e\tau_e \gg 1$, $\Omega_i\tau_i \gg 1$, and (b) $\Omega_e\tau_e \gg 1$, $\Omega_i\tau_i \ll 1$. The increment and frequency of the instability of such a plasma against potential disturbances have been deduced in the linear approximation. Equations of strong turbulence evolved with the aid of Mikhailovski's diagram method have been used in estimating the maximum value of the spectrum function of the electric field of oscillations and of the coefficient of turbulent diffusion. A set of equations of strong turbulence are presented in the dimensionless form suitable for computer analyses. (auth)

29293 (NP–16768) ROL' VYAZKOSTI IONOV V DESTABILIZATSII ZVUKOVYKH KOLEBANII ZAMAGNICHENNOI PLAZMY. (Effect of Ion Viscosity on Destabilization of Sonic Oscillations in Magnetized Plasma). Moiseev, S. S. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 6p. (In Russian). Dep.

The ion viscosity may be the cause of the dissipative instability of an inhomogeneous plasma. In the frequency range of $\omega \sim k_z v_{ti}$ (whereby ω is the perturbation frequency, k_z the projection of the wave vector and v_{ti} the thermal velocity of the ions) no instabilities related to the ion viscosity have been observed; on the other hand, there is a great interest in this range because of its importance for installations with crossed lines of force or with a periodic curvature of the magnetic field lines. Assuming that the plasma temperature is uniform, the role of the ion viscosity in this frequency range was investigated by means of the hydrodynamic approximation for the potential perturbation. The calculations indicated that if $\omega_i < k_z v_{ti}$, consideration of the heat conductivity of the ions along $\vec{H}^0$ and of the ion viscosity related only to the longitudinal motion, results in the stabilization of the instability. From this, it could be shown that in devices with crossed lines of force, the instability yields an anomalous diffusion coefficient which may be much larger than the classic diffusion coefficient. (TTT)

29294 (SIT–3785-3) INVESTIGATIONS IN PLASMA DYNAMICS. Annual Progress Report. Schmidt, George (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Apr. 1967. Contract AT(30-1)-3785. 8p. Dep. CFSTI.

Brief summaries are presented on the following areas of research conducted during this period: guiding-center treatment of finite gyro-radius fluid equations and limiting growth rates for electrostatic instabilities in a relativistic electron plasma with a loss cone distribution function. (M.O.W.)

29295 (CLM-Trans-11) TURBULENT PROCESSES IN TOROIDAL SYSTEMS. Kadomtsev, B. B.; Pogutse, O. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by L. C. Ronson (United Kingdom Atomic Energy Authority, Abingdon, Eng.), from report IAE–1227. 193p. Dep. CFSTI. JCL $13,50 fs, $5,99 mf.

All the principal types of instability which can occur in toroidal systems are considered. The linear theory of the instability of a toroidal column is discussed first. The results of the linear treatment are used as a basis for the subsequent investigation of turbulent processes. The macroscopic transport coefficients are determined and equations describing the plasma motion, including the effect of turbulent processes, are obtained. (auth)

29296 NONLINEAR INSTABILITY. O'Neil, T. M. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 10: 1027-30(May 1967).

A particular type of nonlinear instability is discussed by considering the example of electron plasma waves driven toward instability by a small ion beam but linearly stabilized by electron Landau damping. A spectrum of relatively large amplitude waves is excited, and quasi-linear theory is used to follow their time evolution. It is found that the damping coefficient associated with these waves starts off at the negative value predicted by linear stability theory (i.e., the waves are linearly stable) but that it soon passes to a positive value and thereby demonstrates the existence of the nonlinear instability. The physical origin of the nonlinear instability lies in the fact that the total resonant kinetic energy available for growth is much larger than that available for damping. (auth)

29297 ACOUSTIC KINK INSTABILITY IN AN ARGON DISCHARGE. Schulz, Michael; Ingard, Uno (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 1031-6(May 1967).

An experimental investigation of an acoustic instability of a current-modulated argon discharge in a cylindrical tube is described. When the modulation frequency is coincident with that of a nonaxial acoustic mode of the discharge cavity, the initially straight axial discharge path is deformed into a stationary path in which the lateral displacement has a spatial periodicity along the axis of the tube. This instability occurs only when the modulation exceeds some minimum amplitude and is associated with the excitation of a nonaxial acoustic mode of the gas in the discharge tube. It is shown that the spatial periodicities of the discharge path and the acoustic mode are the same. A proposed explanation of the instability is presented in terms of the acoustic coupling between the discharge and nonaxial acoustic modes and the effect of the acoustic pressure field on the resistance of the discharge. (auth)

29298 NEGATIVE CHARACTERISTIC AND INSTABILITY OF THE COLLISION-DOMINATED HELIUM PLASMA COLUMN. Ecker, G.; Kroell, W.; Spatschek, K. H.; Zoeller, O. (Univ., Bochum, Ger.). Phys. Fluids, 10: 1037-40(May 1967).

The general concept of thermal column instability is applied to

the calculation of Kaufmann's criterion. At the same time a rigorous numerical evaluation of the marginal instability making use of the Myklestad procedure is obtained. (auth)

29299 NEW APPROACH TO PLASMA TURBULENCE. Galeev, A. A. (IAEA, Trieste, Italy). Phys. Fluids, 10: 1041-8(May 1967). (IC-66/82).

An attempt is made to go beyond the framework of conventional weak turbulence theory. A simple dispersion equation for the stability of a steady turbulent state can be found by selective summation of higher-order terms from perturbation theory. The main contribution in the model to be considered here comes from particle motion in the turbulent electric field. In the limit of small wave amplitude, the usual equations of the weakly turbulent plasma can be obtained easily. The theory is applied to the drift-cyclotron instability of a nonuniform plasma to find the steady-state level of drift-cyclotron turbulence. The growth rate of the instability changes essentially at the nonlinear stage, so the usual dimensional arguments to find the turbulent diffusion coefficient cannot be applied using the linear description only. (auth)

29300 NONLINEAR THEORY OF DRIFT-WAVE TURBULENCE AND ENHANCED DIFFUSION. Dupree, T. H. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 1049-55 (May 1967).

The turbulent plasma state which develops from unstable, current-driven drift waves is analyzed. In the nonlinear theory, the wave growth predicted by the linear theory is ultimately suppressed by ion damping. Since the phase speeds of the unstable waves are much greater than the ion thermal velocity, the ions cannot absorb wave energy until they become trapped. The amplitude of the turbulent spectrum grows until trapping occurs, and a quasi-steady state is reached in which the directed electron energy is converted into ion thermal energy at a constant rate. In this state the perturbation of the density gradient due to the turbulence is equal to the mean gradient. Nonlinear limitation due to mode coupling does not suppress the unstable wave growth until much larger density perturbations have developed. Therefore, ion trapping is established as the controlling nonlinear mechanism. In the steady state, the ions diffuse across the magnetic field with a diffusion coefficient $D_\perp \approx (k_\perp^{-2}\gamma)_{max}$, where γ is the growth rate predicted by the linear theory and $k_\perp$ is a perpendicular wavenumber. Although the detailed treatment is for a specific instability, the general conclusions appear to apply to a variety of drift waves. (auth)

29301 ANOMALOUS RESISTIVE INSTABILITY. Fowler, T. K.; Drummond, W. E. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AF49(638)-1546. Phys. Fluids, 10: 1108-9(May 1967).

The question is raised whether microinstability in plasmas causes resistive macroinstability as collisions do. This is found to be unlikely except in extreme cases, according to quasi-linear theory, because only the few resonant electrons experience resistance. (auth)

29302 EFFECT OF TEMPERATURE GRADIENT ON PLASMA STABILITY. Jukes, J. D. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 10! 1107-8(May 1967).

Plasma drift waves in sufficiently inhomogenous, magnetically confined plasma are found to be unstable in theory when collisions between ions predominate. The instability is relatively unaffected by shear. (auth)

29303 SPACE-CHARGE WAVES AND THE ISOTROPY OF THE GALACTIC COSMIC RAY PLASMA. Lerche, I. (Univ. of Chicago). Phys. Fluids, 10: 1071-9(May 1967).

Linearized equations are set up to describe the effect of an electrostatic wave on an anisotropic relativistic proton plasma embedded in a homogeneous magnetic field. It is assumed that a cold background plasma of protons and electrons co-exists with the relativistic plasma. It is shown that instability arises whenever the relativistic proton plasma is anisotropic in the right sense. It is also shown that the growth rates are physically significant for galactic cosmic rays and thus space-charge waves are a mechanism for producing some measure of isotropy in an anisotropic cosmic-ray distribution. For instance, 10% anisotropy yields an e-folding time of about 10^3 years. (auth)

29304 STABILIZATION OF DRIFT WAVES BY SHEAR. Rutherford, Paul H.; Frieman, Edward A. (Princeton Univ., N. J.). Phys. Fluids, 10: 1007-16(May 1967).

The stabilization by magnetic shear of drift (universal) instabilities in a nonuniform, collision-free plasma is reconsidered. The description of the instabilities in terms of normal modes is abandoned in favor of a description in terms of local perturbations which are wave packets of normal modes, and this provides a more appropriate analysis of the effect of shear. The small shear required for stability is found to be of order $(m/M)^{\frac{1}{4}}$ (where m and M are the electron and ion masses) for the short wavelength instability driven by a density gradient only, and results are also obtained for the instabilities driven by electron temperature gradients and longitudinal currents; the instabilities driven by ion temperature gradients are not stabilized by a small shear. (auth)

29305 BOUNCE MODEL PINCH STABILITY. Morse, Richard L. (Univ. of California, San Diego). Phys. Fluids, 10: 1017-26(May 1967).

A cylindrical pinch is treated in the approximation that plasma and field are separated by a thin surface. The external B field is taken to be completely longitudinal as in linear θ pinches. Particles move in straight lines inside of the surface and bounce off of it specularly. Anisotropies in the velocity distribution are shown to result in instabilities of the "mirror" and "fire hose" types as well as flute instabilities of a type which have no analog in small gyroradius theory. Growth rates are obtained and a region of positive stability is found for a particular class of unperturbed distribution functions. The effect of a small net angular momentum is considered. (auth)

29306 CONTRIBUTION TO THE THEORY OF EQUILIBRIUM OF A PLASMA IN A TOROIDAL MAGNETIC TRAP. Solov'ev, L. S.; Shafranov, V. D. Dokl. Akad. Nauk SSSR, 170: 75-8 (Sept. 1, 1966). (In Russian).

An investigation was made to ascertain the applicability of the boundary conditions (the Kruskal and Kulsrud conditions and the Newcomb condition) to the magnetic differential equation of a toroidal equilibrium plasma configuration. Solution of the differential equation for the toroidal magnetic surfaces in the linear approximation shows that the presence of resonant harmonics can either destroy the magnetic surfaces completely, or else under certain conditions lead only to a splitting of the resonant magnetic surfaces into a filamentary structure. Near resonance, only one harmonic of the perturbing field affects the stability of the surface. A method for solving the problem of plasma equilibrium in toroidal magnetic traps, based on the determination of the currents in the plasma and the associated disturbances of the magnetic surfaces, is outlined. It is concluded that the formal solution of the perturbation-theory problem of equilibrium toroidal magnetic configurations contains small denominators analogous to the solutions of perturbation-theory equations in classical mechanics. The difficulties connected with the presence of the small denominators can be circumvented by normalizing (suitably choosing) the unperturbed solution on which the source function of the perturbation-theory equation depends. A concrete method of renormalization is proposed. (ATD)

29307 GRAVITATIONAL INSTABILITY OF A PLASMA WITH DIFFERENTIAL ROTATION. Ebert, R. (Univ., Frankfurt am Main). Z. Naturforsch., 22a: 431-7(Apr. 1967). (In German).

An instability calculation is given for an axially symmetric gas distribution which has a differential rotation and in which a magnetic field is present. It is a generalization of similar calculations given by Chandrasekhar and Bel and Schatzman. The generalization becomes necessary for the study of problems of the formation of planetary systems and star formation. The instability conditions and the critical wave lengths are calculated for plane-wave-like disturbances. For disturbances running perpendicularly to the axis of rotation instability can occur only if the gas density exceeds a critical value which depends on the differential rotation at the considered distance only as long as pressure gradients and gradients of the magnetic field strength are negligible. If the gas density exceeds this critical value the shortest unstable wave length is proportional to the square root of $vT^2 + vB^2$, where vT means the velocity of sound and vB the Alfvèn velocity. For disturbances running parallel to the axis of rotation in addition to the Jeans instability a new type of instability occurs due to the simultaneous action of the magnetic field and the differential rotation; for rigid rotation this instability vanishes. (auth)

29308 INVESTIGATION OF THE STABILITY OF THE PLASMA IN A LINEAR TUBULAR DISCHARGE WITH A SOLID CORE. Marchuk, P. M.; Protsenko, I. M. Zh. Tekh. Fiz., 37: 307-14(Feb. 1967). (In Russian).

The stability of a plasma carrying a current was investigated in the simultaneous presence of longitudinal and azimuthal magnetic fields under such conditions that the criterion of Newcomb and Kaufman (Phys. Fluids, 4: 314(1961)) for stability against gyromagnetic oscillations was satisfied, in order to explore the conditions under which plasmas satisfying the stability condition are nevertheless unstable. The plasmas were produced by discharge of a capacitor bank through an 8-cm-diameter 1-m-long glass tube containing hydrogen, helium, argon, or krypton at pressures from

0.01 to 1 mm Hg. The discharge tube was closed at each end by a metal electrode, and the discharge current was returned through a 1.9-cm-diameter copper rod on the axis of the tube, thus producing the azimuthal magnetic field. The copper rod was insulated from the plasma by a 2.6-cm-diameter quartz tube. A longitudinal magnetic field of up to 12 kOe was produced by discharge of a second capacitor bank through a suitable solenoid. (ATD)

29309 STABILIZATION OF THE DRIFT INSTABILITY OF AN ISOTHERMAL PLASMA IN A TRAP. Ivanov, A. A. Zh. Tekh. Fiz., 37: 229-33(Feb. 1967). (In Russian).

A discussion is presented on the stability to protential perturbations with propagation velocities much lower than the Alfven velocity of a plasma that is entrapped in a magnetic field, has equal ion and electron temperatures, has electron and ion velocity distribution functions each of which depends only on the total kinetic energy and the ratio of the transverse kinetic energy to the magnetic field strength, and in which the kinetic pressure is much lower than the magnetic pressure. The plasma is treated as a plane layer and the magnetic trap is represented by the field of a set of parallel conductors in the plane of the plasma. A dispersion equation is derived from the condition of quasi neutrality and the drift kinetic equation of L. I. Rudakov and R. Z. Sagdeev, and the stability of the plasma is discussed by a rather involved application of the Nyquist criterion. It is shown that the plasma is stable under the given conditions provided the derivatives of both the electron and ion distribution functions with respect to the total kinetic energy are negative for all values of both arguments, and the distribution functions tend to zero more rapidly than the reciprocal of the total kinetic energy as the total kinetic energy tends to infinity. (ATD)

29310 ELECTROSTATIC STABILITY OF PLASMAS OF FINITE LENGTH. Cotsaftis, M. (EURATOM-CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 7: 3-16(May 1967). (In French).

Using a plane-geometry model developed previously for the study of flute instabilities having a general equilibrium state, and taking into account the finite dimension of the plasma along the magnetic field and the possible presence of a cold plasma between the plasma and the conducting plates, electrostatic instabilities are studied which, when the plasma becomes infinite, give rise to instabilities propagated "perpendicular" to the magnetic field. The dispersion relation for the flutes is studied for the Mikhailovski-Timofeev gradient instabilities and for the loss cone instabilities, which are analyzed in greater detail since they entail particularly stringent criteria in infinite geometry. The stability limit is presented as a set of curves depending on two parameters. The values assumed by these two parameters can be divided into two quite distinct groups corresponding to longitudinal and transverse injection. The two groups of values lie in the plane to either side of a critical line that divides the stability analysis into two distinct regions. Starting from this dividing line it is possible to write in each region "approximate" criteria that are more simple but indicate general trends. Devices with longitudinal injection cannot be stabilized by cold plasma and finite length effects. Devices with transverse injection offer better stabilization possibilities; under present conditions, however, it is probably necessary to increase the plasma density by one or two orders of magnitude. The flute instabilities are stabilized at the same time. Since the effect of gravity appears to be slight, the results accordingly suggest that, for obtaining a stable plasma, "short" high-density devices with a simple mirror are preferable to "long" devices with a magnetic sink. It remains to be seen, however, whether the effect that has been described mathematically is physically acceptable. (auth)

29311 KELVIN INSTABILITY IN CURRENT-CARRYING COLD PLASMAS. Talwar, S. P.; Kalra, G. L. (Univ. of Delhi). Nucl. Fusion, 7: 17-24(May 1967).

The electrostatic instability caused by a tangential discontinuity of velocity in two semi-infinite homogeneous regions of a cold and collisionless plasma subject to a uniform magnetic field is investigated using two fluid equations. A general dispersion relation is derived allowing for interstreaming of charged particles in each region in addition to a slippage of one region over the other. Special cases are then discussed and the criteria for stability, monotonic instability and growing wave instability are derived. (auth)

29312 CONTROL OF ION–ACOUSTIC WAVE INSTABILITIES IN A GASEOUS DISCHARGE. Coleman, James T. (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 38: 2655-9 (May 1967).

The marginal-stability boundary for spontaneous generation of ion–acoustic waves in a nonequilibrium plasma is investigated experimentally. The transition from inverse Landau damping to normal Landau damping of the acoustic wave modes is demonstrated by observing the change in forward-scattering cross section of microwave electromagnetic energy. The measured scattering cross section is compared with that predicted by Ichimaru, using a simple relaxation-time collision term in the Boltzmann equation. In addition, the collision term of Bhatnagar et al., is used to construct a new marginal-stability boundary. The latter expression seems to give a better comparison with the observed microwave scattering and demonstrates the superiority of the more realistic collision-term model. (auth)

29313 APPROXIMATE EQUATIONS FOR PLASMAS IN MIRROR MACHINES. Rosenbluth, M. N.; Varma, R. K. (Univ. of California, San Diego, La Jolla). Nucl. Fusion, 7: 33-55(May 1967).

By expanding in terms of the parameter ϵ = ion Larmor radius/plasma radius ($\epsilon \ll 1$), sets of approximate equations are obtained from Vlasov's equation for the low-β inhomogeneous plasma equilibria which occur in the inhomogeneous magnetic fields of the mirror machines. The different sets correspond to different physical regimes which require different ordering of the parameters. Thus at very low densities ($b^2 = 4\pi nMc^2/B^2 \ll 1$), it is essential to order various terms in Vlasov's equation such that the precessional drift velocity is of the same order as the frequency of the motion. This implies $\omega \approx \epsilon^4\Omega_i$ for a "long-thin" machine ($r \sim \epsilon^2\rho$), and $\omega \approx \epsilon^2\Omega_i$ for a "short-fat" machine ($r \sim \rho$). In either case the "closed" equation for the phase-averaged zero-order distribution function $f_0^{(0)}$ is found to be identical to the Northrop–Teller "Liouville equation" for the guiding center with the $\mu\nabla B$ and the curvature drifts appearing in the same order as the frequency of the motion. For a high-density plasma ($b^2 = 4\pi nMc^2/B^2 \gg 1$) the terms are ordered such that $\omega \approx \epsilon^2\Omega_i$ for "long-thin" machine (the finite Larmor radius case). The set of approximate equations for this case and the resulting eigenvalue equation are found to be completely analogous to those for the cylindrical geometry as found by Rosenbluth and Simon. In particular, for the "special case" of Rosenbluth and Simon the $m = 1$ mode is found to be neutral stable, in the absence of gravity as in the hydromagnetic limit. (auth)

29314 FLUTE INSTABILITY IN MIRROR MACHINES AT VERY LOW DENSITIES. Varma, R. K. (Univ. of California, San Diego, La Jolla). Nucl. Fusion, 7: 57-71(May 1967).

The flute instability of low-β axially symmetric plasma confinement devices is studied. From the set of equations for the low-density case, without an equilibrium space-charge potential, and with a near δ-function distribution of energies appropriate to neutral injection devices, a variational principle is derived for the three-dimensional mirror machine geometry. In general, for small electron temperatures the variational principle furnishes a dispersion relation which for given trial functions is cubic. Two roots of the cubic furnish the stability criterion. The third root describes a density-independent mode of oscillation at a frequency equal to the ion precessional frequency, and is identified with the density-independent mode observed in the Alice machine. The order of magnitude of the critical plasma density for flute instability is the same as that obtained by previous authors using the drift approximation, but by use of the variational principle it is possible to obtain a more quantitative stability criterion, in particular an estimate of the effect of the finite plasma length. The critical plasma density is presented as a function of the ratio of the length to the radius of the plasma. (auth)

29315 ENERGY SPREADING AND STABILIZATION OF PLASMA BY APPLYING A HIGH-FREQUENCY ELECTRIC FIELD. Kuo-Petravic, L. G.; Murphy, E. G.; Petravic, M.; Sinclair, R. M.; Sweetman, D. R.; Thompson, E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 7: 25-7(May 1967). (CLM-P–108).

The ion cyclotron instabilities in the Phoenix high-energy injection mirror machine have been suppressed by applying oscillating electric fields. Two instabilities appear to be present. One is suppressed by energy spreading and the suppression of the other appears to be due to the effect of the applied electric fields on the electrons. (auth)

29316 INSTABILITY OF NONUNIFORM FLOW OF A PLASMA ALONG A MAGNETIC FIELD. Petviashvili, V. I. Zh. Tekh. Fiz., 37: 206-7(Jan. 1967). (In Russian).

E. R. Harrison (Proc. Roy. Soc., 82: 689, 1963) has shown that electron oscillations are excited in a plasma moving along a magnetic field provided the gradient transverse to the magnetic field does not vanish. It is shown that under these conditions there can also be excited electron–ion drift oscillations. The plasma is assumed to have a high electron temperature and to move in a uniform magnetic field. In the hydrodynamic approximation with the ion pressure neglected there is derived a dispersion equation for plane waves whose transverse wavelength is short compared with the lengths characteristic of the plasma inhomogeneity. When the

plasma velocity gradient transverse to the magnetic field vanishes, this dispersion equation reduces to the usual equation for drift oscillations. The plasma can become unstable when the transverse plasma velocity gradient does not vanish. The condition for stability is that dv/sdx not exceed dn/ndx in absolute value, where v is the velocity of the plasma along the magnetic field, s is the velocity of ionic sound in the plasma, n is the plasma density, and x is a coordinate transverse to the magnetic field. (ATD)

Thermonuclear Processes

29317 (LA-tr-67-42) SOURCE OF NEUTRONS BY PLASMA FOCUS: DESIGN AND FIRST RESULTS. Patou, C.; Simonnet, A.; Watteau, J. P. Translated by Gretchen R. Riese (Los Alamos Scientific Lab., N. Mex.), from Report No. 66-12/DO-034/W/PG. 66p. Dep. CFSTI. JCL $6.60 fs, $2.18 mf.

The performances of various neutron sources are compared. After a short summary of the phenomena of self-striction, various theoretical models are considered which make it possible to take into consideration the mechanism governing a rapid electric discharge with non-cylindrical symmetrical geometry. The experimental arrangement is described. A theoretical model has been chosen (snow plow model) to support a numerical calculation. The results obtained from this model are compared to the experimental results. The various possibilities of improving the performance of this source are considered from the point of view of use. Actually, for an electrical energy of 15 kJ, 10^9 neutrons were obtained for 4π steradians, the emission lasting 100 ns, that is, 10^{16} neutrons per second in 4π steradians. (auth)

29318 EMISSION OF NEUTRONS BY NON-CYLINDRICAL ROTATING DISCHARGES. Patou, Claude; Simonnet, Alain; Watteau, Jean-Paul (Centre d'Etudes de Limeil, Val-de-Marne, France). Compt. Rend., Ser. A and B, 264: 432-5(Feb. 6, 1967). (In French).

A parallelism of functioning of two noncylindrical rotating discharges is established. In these discharges the formation of a tight magnetic piston is favored by high pressure and the presence of impurities. In the hypothesis of a thermalization, taking account of the high compression rate and the magnetic energies given up to the plasma at the end of the compression, an attempt is made to justify the number of neutrons observed. (tr-auth)

29319 SHOCK WAVES AT HIGH TEMPERATURES. I. Masani, A.; Borla, V.; Ferrari, A.; Martini, A. (CNR, Turin). Nuovo Cim. (10), 48B: 326-57(Apr. 11, 1967).

Plane one-dimensional shock wave propagations are considered at temperatures and densities where electron-positron pairs are produced and thermonuclear reactions or neutrino emissions play an important role. In order that the stellar-type plasma, in which the shock is propagated, can likely reach a temperature T_2 high enough to start these processes, the propagation velocities must be quickly relativistic. Therefore, after accurate nonrelativistic analysis of the problem, we have turned to the relativistic case. Among the principal results obtained, we want to emphasize the fact that the density ratio ρ_2/ρ_1 (which has 4 as upper limit for very strong shocks propagating in a perfect gas without radiation pressure, and 7 in a gas in the presence of radiation) can reach, because of pair formation, the value of 14 (approximately) in the nonrelativistic case; moreover in the relativistic case ρ_2/ρ_1 can increase without any limit. Nevertheless the gas does not become degenerate because of the increase of temperature. But, when the density ρ_2 reaches values higher than 10^{12} g/cm^3, one should take into account the transformation of the gas into a free-neutron gas; and when ρ_2 is of the order of the nuclear density ($\approx 10^{14}$ g/cm^3) the typical phenomenology of nuclear matter becomes necessarily important. The present considerations are valid only as long as ρ_2 (proper density, i.e., measured in the particle frame) does not exceed the value 10^{12} g/cm^3. It must however be kept in mind that these limits could be attained only by means of very strong shocks. The effects that the thermonuclear processes, neutrino emissions and iron-helium transitions produce on the shock propagation are discussed, and the conclusion is that they are negligible (with the exception of some detonating reactions). (auth)

Shielding

Refer also to abstract 28473.

29320 (JINR-P9-3269) NAKOPLENIE V ZASHCHITE ZARYAZHENNOGO KOMPONENTA IZLUCHENII. (Buildup of Charged Radiation Component in the Shielding). Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 6p. (In Russian). Dep.

Solution of an equation of charged particle transport in the semi-infinite space is presented. The main assumptions, in writing the equation, are the neglect of the secondary cascade processes under the action of charged particles and of the Coulomb scattering. The way obtained to solve this equation allows one to calculate, comparatively easy, the distribution function of the charged particle flux density, when the source density distribution is given. (auth)

29321 (NASA-TM-X-1397) QADHD POINT-KERNEL RADIATION SHIELDING COMPUTER CODE TO EVALUATE PROPELLANT HEATING AND DOSE TO CREW DURING ENGINE OPERATION. Lahti, Gerald P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1967. 90p. CFSTI.

A FORTRAN IV computer program, QADHD, based on the LASL code QAD4, was written to evaluate the propellant heating in a nuclear rocket stage and to calculate the gamma and fast neutron doses received by a crew from the radiation emitted by the nuclear engine during the operating period. The QADHD is a combination of three codes, QAD4, QADH, and QADD. The LASL QAD4 is a general purpose program written to calculate gamma and fast neutron doses due to a volume-distributed source in a complex source-shield geometry that is generally describable by quadratic surfaces. QAD4 is a point-kernel code that employs infinite-medium buildup factors to calculate the gamma dose and employs the Albert-Welton kernel to calculate the fast neutron dose. The QAD4 included here was revised slightly from the LASL version to facilitate its use in the QADHD, as well as to simplify data input. QADH utilizes the QAD4 routines to evaluate local heating throughout the propellant (and tank wall) and then integrates these heating rates over the entire volume of the propellant. Assuming that this heat is distributed uniformly throughout the propellant by natural convection (the complete-mix model) permits the rate of temperature rise of the propellant to be determined. QADH then determines the total temperature rise and accumulative heat input to the propellant as a function of reactor operating time. In some nuclear rocket configurations, the propellant may serve to shield the crew from radiations emitted by the engine. In these cases QADD utilizes the QAD4 routines to calculate biological dose rates to the crew during engine operation while the propellant depth in the tank (or amount of shielding the propellant provides) changes with time. QADD then integrates these dose rates over engine operating time to obtain a total dose-time history. (auth)

29322 (NP-16791) A CRITICAL EVALUATION OF THE MARKOV MATRIX TREATMENT OF NEUTRON DIFFUSION IN SLABS. Eaton, M. L.; Huddleston, C. M. (Naval Civil Engineering Lab., Port Hueneme, Calif.). May 1967. 52p. (R-529). CFSTI.

It is known that a method based on the concept of a Markov chain can be used to treat the problem of absorption, transmission, and backscatter when single-velocity neutrons are incident on a plane slab of finite thickness, under the assumption that scattering is isotropic in the laboratory system. Such conditions can exist when neutrons impinge on a slab of material, such as a shield or an inside wall of a shelter entranceway. Since the Markov matrix method is a new approach to the problem, the practical limits in applying the method have not previously been explored. The region of usefulness of the matrix method is outlined. The solutions to some sample problems are given. Comparisons are made with other theoretical treatments. It is concluded that the Markov matrix method is useful over a wide region of interest. Within its limits of practical applicability, the method gives highly exact answers without requiring exorbitant computing time. (auth)

29323 (NP-16792) EXPERIMENTAL DETERMINATION OF NEUTRON ENERGY SPECTRA IN CONCRETE DUCTS. Gardner, Leonard B.; Mettler, Alan J.; Burdick, Bernard (Naval Civil Engineering Lab., Port Hueneme, Calif.). May 1967. 84p. (R-523).

Neutron energy spectra were experimentally determined at various positions in air ducts through concrete. The ducted concrete structures studied were built as model entranceways for protective shelters. The spectra were determined for the case of 14-MeV neutrons impinging on the duct entrance, and were based on activation analysis of threshold foil detectors, foil sandwiches, and bare and cadmium-covered indium foils. The experimentally determined spectra were compared to available spectra calculated by Monte Carlo techniques utilizing the ADONIS computer code. From the spectra the dose was calculated and the results were normalized to the dose in free air at one centimeter from the source. The normalized dose, as a function of distance in the duct from the source, is graphically compared for the several analysis techniques. The data presented demonstrate that it is possible to determine the neutron energy spectrum in ducts by the technique of foil activation. Such determinations are useful during the experimental optimization of the protection factor for the duct in which the inclusion of doors, traps, liners, and special wall ma-

terials are considered. The data presented herein form a basis for understanding the effect of duct geometry on the protection factor, that is, the inverse of the dose rate at various positions in the duct normalized to the dose rate at the entrance of the duct. (auth)

29324 (ORNL-TM-1794) NEUTRON FLUXES IN CONCRETE DUCTS DUE TO INCIDENT EPICADMIUM NEUTRONS: CALCULATIONS AND EXPERIMENTS. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). May 17, 1967. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Monte Carlo calculations have been carried out to determine subcadmium and epicadmium neutron flux distributions along the center line of a straight, a two-legged, and a three-legged square concrete duct arising from the slowing down of incident epicadmium neutrons for a particularly demanding source geometry and spectrum. The calculations used albedo data differential both in the reflected angles and reflected energy which have been reported previously for concrete. A comparison of the results of these calculations with those from a geometrically similar experiment shows good agreement and places on a firm foundation the concept of treating neutron slowing down in a concrete duct as a reflection phenomenon at a point which is describable by the differential albedo properties of the walls. The conclusion is also reached that the dose rates arising from the subcadmium neutrons (whether due to an epicadmium source or a subcadmium source) and associated secondary wall capture gamma rays can comprise a very important part of the total absorbed dose rate in tissue deep inside a multilegged duct. (auth)

29325 (USNRDL-TR-67-42) GAMMA-RAY TRANSPORT PROPERTIES OF A CYLINDER PLACED BEHIND AND AXIALLY PERPENDICULAR TO A SLAB. Plummer, George E.; Shumway, Bruce W. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 11, 1967. 36p.

A series of concentric annular zones on a steel slab were irradiated serially by a fixed, point gamma-ray source. Exposure rate measurements were made behind the barrier along the normal from the source. Next a steel cylindrical partition was placed behind the barrier with its axis normal to the slab. This partition was in contact with the slab and concentric with the source detector axis. Exposure rate measurements along the axis were repeated. The two sets of measurements are presented and compared zone by zone to see what changes were brought about by the insertion of the partition. (auth)

29326 (WANL-TME-1273(Rev.A)) N-SAP AND G-SAP NEUTRON AND GAMMA RAY ALBEDO MODEL SCATTER SHIELD ANALYSIS PROGRAMS. Stephenson, L. D.; Sapovchak, B. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 1966. Contract SNP-1. 86p. Dep. CFSTI.

The formulation and operation of the N-SAP (neutron scatter) and G-SAP (gamma scatter) programs are described. These programs use albedo techniques to compute neutron or gamma-ray scattering from plane or cylindrical surfaces. (auth)

29327 DISTRIBUTION OF ABSORBED ENERGY FROM A POINT BETA SOURCE. Cross, W. G. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys., 45: 2021-40 (June 1967). (AECL-2891).

The distribution of absorbed energy/g (dose) around a point source in a homogeneous medium has been measured for a variety of beta emitters in air, argon, ethane, and expanded polystyrene. At short distances the dose falls off faster than $1/r^2$, contrary to the results of measurements in solids but in agreement with previous measurements in air for maximum beta energies below 1.6 MeV. Except at short distances, distributions in different media differ only by a constant scaling factor on distance (mg/cm^2) that is the same within ±1% for all beta energies considered, but that is not proportional to electron density. Except close to the end of the range, the absolute doses calculated from Spencer's numerical solutions of the transport equation agree with the measured values within about ±4%, for maximum beta energies from 0.16 to 3.58 MeV and for a wide variety of spectral shapes. The calculations predict correctly the observed variation of attenuation with the atomic number of the medium. (auth)

29328 METHOD OF EVALUATING FAST-NEUTRON DIFFERENTIAL SCATTERING CROSS SECTIONS WITH SHORT EXPERIMENTAL RUNS. Verbinski, V. V.; Courtney, J. C.; Betz, N. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Instrum. Methods, 52: 181-92(1967). (ORNL-P-2891).

The method utilized a pulsed neutron source with a smooth, broad spectrum, making it possible to measure neutron scattering from 0.5 to 10 MeV in a single run of 1 to 2 h duration for each scattering angle θ. Scattering samples of carbon, aluminum, iron, lithium hydride and concrete about 5 cm in dia. were located about ⅓ m from the pulsed neutron source, and neutrons scattered through an angle θ were directed down a 55-m flight path to a liquid organic scintillator used to measure the time-of-flight spectrum of scattered neutrons. The energy-dependent neutron intensity thus obtained was compared with Monte Carlo calculations whose inputs were the measured neutron source term and neutron elastic, inelastic, and reaction cross sections compiled from the existing literature. The comparison provides direct corrections to the cross sections for the lighter elements because single scattering is about ten times more probable than multiple scattering with the sample sizes chosen. These corrections can be further improved by repeating the calculation with the improved cross-section values. Inelastic scattering into any given energy region was small compared with elastic scattering for low Z scatterers because of the shape of the source spectrum. In this case, the method provides an unambiguous check on the elastic differential scattering cross sections used as input for the Monte Carlo calculations, and good first-order corrections to these cross sections. Several modifications of both experiment and calculation are proposed for reducing the statistical uncertainty, for improving the experimental and calculational efficiencies, and for increasing the range of energy covered. (auth)

29329 THE ABSORBED DOSE RATE FROM BOTH THE UNCOLLIDED AND THE ONCE-COLLIDED FLUX OF GAMMA RAYS AT THE CENTER OF A SPHERICAL SHELL SHIELD BOMBARDED BY AN ISOTROPIC FLUX SPECTRUM OF PROTONS. Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y.); Shulman, Harold. Nucl. Sci. Eng., 28: 353-8(June 1967).

A sevenfold integral expression is derived for the absorbed dose rate from the uncollided flux of γ rays at the center of a spherical shell shield bombarded by an omnidirectional flux spectrum of protons. The general formulation is reduced to a fourfold integral on the basis of simplifying assumptions. This simpler formulation assumes that the γ rays are produced isotropically by an isotropic proton flux, that protons penetrating the shell are not deflected from their original direction of incidence, that the spectrum and yield of photons are independent of proton bombarding energy, and that both the incident proton spectrum and the range–energy relation for protons in matter have power-law representations. A sixfold integral expression is derived for the absorbed dose rate from the once-collided flux of γ rays at the center of a spherical shell shield bombarded by an isotropic flux spectrum of protons. The once-collided differential (in energy) flux of photons at the shell center is given by a fivefold integral expression. (auth)

29330 A METHOD FOR THE CALCULATION OF ALBEDO MATRICES BY MEANS OF PEIERLS INTEGRAL EQUATION. Vertes, Peter. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 165-82 (1967). (In Hungarian).

The basic theorems of the albedo method are outlined and a procedure for the numerical calculation of albedo matrices in terms of the multigroup Peierls integral equation is presented with full details. (auth)

29331 GENERALIZED GAMMA TRANSPORT PROGRAM, BIGGI. Penkuhn, H. Atomkernenergie, 12: 81-4(Mar.-Apr. 1967). (In German).

The Fortran program BIGGI 4 solves the Boltzmann equation for gammas numerically in plain or spherical multilayer geometry without iteration (since there is only energetic downscattering). The buildup factors calculated in this way are compared with those of the moments method. The simulation of a point source can lead to difficulties because of the possible highly anisotropic angular fluxes. (auth)

29332 POSSIBILITY OF THE NUMERICAL TREATMENT OF AN ENERGY FLUX INTEGRAL. Steinhoff, G. (VEB Atomkraftwerk, Berlin). Kernenergie, 10: 84-5(Mar. 1967). (In German).

The energy flux of scattered gamma rays in a point under consideration is calculated by using Simpson's rule. The interval pitch is adjusted section by section with the aid of the trapezoidal rule. The result is dependent on a preset limit of accuracy only. (auth)

29333 INCOHERENT-SCATTERING OF GAMMA-RAYS IN LEAD. Parthasaradhi, K.; Rao, V. Visweswara (Andhra Univ., Waltair, India). Curr. Sci. (India), 36: 289(June 5, 1967).

With a view to studying the electron binding effect and its variation with energy in lead, the ratio (σ_b/σ_f) is determined experimentally. The differential free-electron scattering cross sections are numerically integrated after correcting for the binding effects at each angle using the S(v) functions of Thomas–Fermi, to get the integral bound electron scattering cross section (σ_b). The ratio of this value to the free-electron scattering cross section (σ_f) gives the theoretical ratio (σ_b/σ_f). The results are given. (M.O.W.)

Solid-State Physics

Refer also to abstracts 28267, 28802, 28849, and 29850.

29334 (BNL-11401) USES OF RESEARCH REACTORS FOR RESEARCH INTO THE STRUCTURE OF LIQUIDS AND SOLIDS. Palevsky, Harry (Brookhaven National Lab., Upton, N. Y.). May 12, 1967. 41p. (CONF-670501-12). Dep. CFSTI.

From International Conference on Research Reactor Utilization and Reactor Mathematics, Mexico City, Mex.

The uses of research reactors for research into the structure of liquids and solids and a development of the principles involved in the research were presented. (auth)

29335 (COO-1054-30) OPTICAL AND ELECTRON PARAMAGNETIC RESONANCE STUDIES OF SODIUM FLUORIDE. Andrews, Ronald A. (Wayne State Univ., Detroit, Mich.). 1966. Contract AT(11-1)-1054. 115p. Dep. CFSTI.

Thesis.

Optical bleaching and the role of impurities in the bleaching process were studied. The experiments make use of iron as an impurity in sodium fluoride which is colored by x rays near room temperature. Discussions are included on the interaction of x-ray photons with the iron impurity. The results provide information concerning the interactions among various color centers, impurities, and the lattice. The investigations were made by the methods of electron paramagnetic resonance and optical absorption spectroscopy at controlled temperatures between 4.2 and 300°K. (J.H.M.)

29336 (IS-T-117) MOESSBAUER EFFECT STUDY OF THE MAGNETIC STRUCTURE OF SINGLE CRYSTAL ERBIUM. Reese, Richard Allan (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 90p. Dep. CFSTI.

Thesis.

The rare earth metal erbium exists in three magnetically ordered states below its Néel temperature of 85°K. The magnetic structure of these three states was studied using the Mössbauer effect with single crystal absorbers. The ratios of the areas under the hyperfine absorption maxima are related to the angle between the direction of magnetization and the gamma-ray propagation direction. By studying these area ratios it was possible to obtain information about the magnetic structures. In the low-temperature region (below 20°K), analysis of the data, on the assumption of a cone structure, yields a value of 26 ± 3° for the semi-apex angle of the cone. In the intermediate temperature region (20 to 52°K), five line Mössbauer absorption spectra were obtained which were qualitatively similar to those obtained in the low-temperature phase. In the high-temperature phase, (52 to 80°K), a two line Mössbauer spectrum was obtained when the c-axis of the crystal was parallel to the gamma beam. For the heavy rare earths the hyperfine field is principally due to the polarization of the 4f electrons, so that the hyperfine field is proportional to the magnetic moment of the ion. The observation of a well-resolved spectrum indicates that the range of values for the hyperfine field is no larger than that found for the other two phases. The temperature dependence of the magnetic hyperfine field and the electric quadrupole interaction were measured between 4.2 and 80°K. Although the probable errors are quite large, a T^2 temperature dependence appears to fit the data better than a T^5 or a Brillouin function dependence. The value of the magnetic hyperfine field extrapolated to 0°K is $7.71 \pm 0.15 \times 10^6$ Oe. The quadrupole splitting decreases with temperature to about 50°K where it can no longer be separated from the experimental noise. (auth)

29337 (IS-T-161) DEFECT-DEFECT INTERACTIONS IN THE SILVER HALIDES WITH SPECIAL APPLICATION TO PURE SILVER CHLORIDE. Sevenich, Richard Anthony (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 123p. Dep. CFSTI.

Thesis.

The effect of defect-defect interactions on the equilibrium concentration of intrinsic Frenkel defects in the silver halides was investigated employing the formalism developed by Allnatt and Cohen. The defect concentrations in silver chloride were calculated self consistently for the temperature range 400°K to melting. This formalism was quite adequate for a Frenkel pair formation energy given by 1.48 to 10.4 kT. The agreement between the Lidiard theory and this calculation was good below 620°K and above 620°K the Lidiard theory remained a first approximation. Use of a smaller free energy of formation indicated that in this case the Lidiard result was the first term in a slowly converging series at intermediate temperatures. At high T the rising dielectric constant weakened the Coulomb interaction sufficiently so that the theory converged. There were two striking results of the investigation. The first was the occurrence of a maximum in Δg, the change in the free energy of formation due to defect-defect interactions. It was shown that this maximum was to be expected in the case of the Lidiard theory. The second interesting result was that not all input parameters are consistent with the equations of the theory. This fact was investigated for the simple case of the Debye-Hückel potential to find that there are a region of no roots to the equation for Δg, a region of two roots, and a point where there is one root separating the no-root and two-root regions. (auth)

29338 (LA-3670) INSTABILITY AND PHASE TRANSITION IN AN ANHARMONIC CHAIN. Shier, John S. (Los Alamos Scientific Lab., N. Mex.). Feb. 1967. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A simple anharmonic chain model is presented, and it is demonstrated how the anharmonic forces give rise to a low temperature instability and a phase transformation. Approximate expressions are given for the transition temperature and the interaction strength necessary to produce a phase transformation. (auth)

29339 (NASA-TN-D-3989) PROTON BOMBARDMENT OF HIGH-PURITY SINGLE-CRYSTAL SILICON. Robertson, J. B.; Franks, R. K. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center); Gilmer, T. E. Jr. (Virginia Polytechnic Inst., Blacksburg). May 1967. 25p. CFSTI.

Bombardment of high-purity silicon with 22-MeV protons has produced ^{27}Al at a rate of 6×10^{-3} atom per proton in a thick target. The aluminum was identified by the Al_s infrared absorption spectrum. The production of aluminum in the crystals eliminated the study of damage in impurity-free silicon but, in return, provided for a study of defect interactions with aluminum. The production rate of aluminum is high enough that anyone studying radiation damage by protons should be aware of the presence of the aluminum. Three new infrared absorption bands were observed in the irradiated silicon with main peaks at 8.9, 14.2, and 21.0 microns. Production of the 21.0 μ band required high sample temperature during bombardment and is identified as (substitutional aluminum) + (vacancy cluster). The 8.9- and 14.2-μ peaks appear and disappear with successive annealing. The possibility is mentioned that one or both of these lines might be due to $(Al_{substitutional} + Al^{++}_{interstitial})^+$. The 20.5-$\mu$ absorption band, which has been reported in neutron-irradiated silicon, was found in proton-irradiated silicon. (auth)

29340 (PRNC-25) THERMAL HYSTERESIS IN BARIUM TITANATE. Gonzalo, Julio A. (Puerto Rico Nuclear Center, Mayaguez). Oct. 1963. Contract AT(40-1)-1833. 23p. Dep. CFSTI.

None of the existing theories on the ferroelectric behavior of barium titanate explain the presence of thermal hysteresis. A qualitative interpretation is given of the thermal hysteresis phenomenon based on a local field action in a new potential-well model which has proper symmetry in each crystallographic phase and is built directly on the neutron diffraction data for the Ti^{+4} position in the unit cell. Numerical calculations of the hysteresis yield rather good agreement with published experimental data, but in order to carry out the calculations it was necessary to make certain simplifying assumptions to obtain the local field and behavior of the energy barrier at the transition points. (auth)

29341 DIFFUSION OF XENON IN BARIUM FLUORIDE. Schmeling, P. (Kernforschungszentrum, Karlsruhe, Ger.). Phys. Status Solidi, 20: 127-9(Mar. 1, 1967).

The diffusion of xenon in barium fluoride after irradiation with reactor neutrons is studied. Above 1000°C the diffusion process is characterized by an activation energy of 3.7 eV and is independent of the neutron dose. (auth)

29342 ELECTRON SPIN RESONANCE OF Tl^{++} CENTRES IN KCl CRYSTALS. Dreybrodt, W.; Silber, D. (Univ., Frankfurt am Main). Phys. Status Solidi, 20: 337-46(Mar. 1, 1967).

Thallium-doped KCl crystals are x irradiated at 77°K. They are warmed up to 300°K and then cooled down again to 77°K. ESR signals showing a resolved hyperfine structure due to six chlorines are observed. These arise from a Tl^{2+} ion on a cation lattice site. The constants of the spin-Hamiltonian are determined. Watanabe's theory is used to determine the coefficients of the ground state LCAO function from the hfs constants. From these data and from data of the optical absorption spectrum of Tl^{2+} the g-shift is calculated and compared with the experimental value. (auth)

29343 TRANSIENT FADE AWAY AND ANISOTROPY OF p-TERPHENYL AND p-TERPHENYL-ANTHRACENE MIXED CRYSTALS AFTER BOMBARDMENT WITH α-PARTICLES. Weiss, Jakob (Univ., Goettingen, Ger.). Z. Phys., 203: 37-48(1967). (In German).

The time dependence of scintillation intensity from single

crystals of p-terphenyl and mixed crystals of p-terphenyl and anthracene after bombarding with α particles was investigated at the two temperatures T = 296°K and T = 92°K. For the crystals of p-terphenyl the time dependence of the scintillation anosotropy was also measured. Using the formulas given by King and Voltz the decay curves of p-terphenyl were decomposed into two components. Good agreement between experiment and theory was found. The ratio of the prompt intensity to the delayed intensity was determined to be 1 : 2 at T = 296°K and 1 : 3 at T = 92°K. The diffusion constants for triplet excitons were calculated to be $D_T(296°K) \approx 10^{-5}$ cm^2 sec^{-1} and $D_T(92°K) \approx 2 \times 10^{-6}$ cm^2 sec^{-1}, and the triplet–triplet interaction rate constants $\chi_{tt}(296°K) \approx 2.5 \times 10^{-11}$ cm^3 sec^{-1} and $\chi_{tt}(92°K) \approx 0.5 \times 10^{-11}$ cm^3 sec^{-1}. (auth)

29344 VARIATIONS IN FUNCTION OF THE TEMPERATURE OF THE ELASTIC LIMIT AND OF THE ELECTRIC CHARGE OF DISLOCATIONS IN IRRADIATED LITHIUM FLUORIDE CRYSTALS. Serughetti, Jean; Schaeffer, Bernard; Dupuy, Claude H. S.; Saucier, Henri (Faculte des Sciences, Strasbourg). Compt. Rend., Ser. A and B, 264: 474-7(Feb. 6, 1967). (In French).

An apparatus was developed that makes it possible to measure in a heated state the electric charges appearing during plastic deformation. The charge of the dislocations can thus be calculated per unit length between 25 and 300°C. A comparison of the results with those obtained for the elastic limit indicates that the complete recovery from irradiation is made near 500°C. (tr-auth)

29345 ANALYSIS OF THE MAGNETIC HYPERFINE STRUCTURE OBSERVED USING THE MOESSBAUER EFFECT IN Tm METAL. Cohen, R. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 24A: 674-5(June 5, 1967).

Complex Mössbauer-effect hyperfine spectra similar to those previously observed have been analyzed using a simple model based on the neutron diffraction solution of the magnetic structure. Previous difficulties in reconciling the observed spectra with this structure of Tm metal are resolved under the assumption of slightly incommensurate magnetic and crystal lattices. (auth)

29346 CRITICAL DISTANCES IN PROTON DIFFRACTION. DeWames, R. E.; Hall, W. F.; Chadderton, L. T. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Lett., 24A: 686-7(June 5, 1967).

A calculation of critical distances for proton diffraction in channeling experiments indicates that the diffracted wave cannot be neglected. (auth)

29347 ON THE ENERGY SPECTRUM OF keV ELECTRON SCATTERING WITH SMALL ENERGY LOSSES. Rumyantsev, V. V. (Leningrad Polytechnic Inst.). Phys. Lett., 24A: 697-8 (June 5, 1967).

The form of the energy spectrum of electrons scattering with energy losses smaller than band gap is discussed. In this case, almost the whole energy loss is transferred to electrons of the conduction band and the momentum is transferred to the electrons and the lattice. (auth)

29348 NMR QUADRUPOLAR EFFECTS IN NEUTRON-IRRADIATED LiF. Charvolin, J.; Cohen-Addad, J. P.; Froidevaux, C. (Univ., Paris, Orsay, France. CNRS, Paris). Solid State Commun., 5: 357-60(May 1967).

Quadrupolar effects were observed in the NMR spectrum of neutron-irradiated LiF crystals. This is related to the presence of Li atom precipitates which are of two types — small platelets and bigger isotropic clusters. (auth)

29349 ION BOMBARDMENT OF SOLIDS. Grant, W. A.; Carter, G. (Univ. of Liverpool). Metals Mater., 1: 176-81(June 1967).

The phenomena arising from the bombardment of solids by energetic ions are of considerable practical importance, for example in the development of ultra high vacuum pumps, and in thin film sputtering techniques. A discussion is presented of the implications of studies now being made in the Department of Electrical Engineering and Electronics at the University of Liverpool. (auth)

29350 CORRELATION EFFECTS IN THE BAND STRUCTURE OF GRAPHITE. Linderberg, Jan; Maekilae, Kalle V. (Uppsala Univ.). Solid State Commun., 5: 353-6(May 1967).

Dynamical electronic correlation is investigated for graphite layers in a tight-binding model suggested by Hubbard. Changes in the density of states are small, but the damping of quasiparticle states is considerable. (auth)

29351 LATTICE PARAMETER CHANGES IN NEUTRON IRRADIATED ALUMINUM. Himmler, U.; Peisl, H.; Sepp, A.; Waidelich, W.; Wenzl, H. (Technische Hochschule, Darmstadt, Ger. Technische Hochschule, Munich). Z. Angew. Phys., 23: 8-15(June 1, 1967). (In German).

Pure aluminium foils were irradiated at 4.6°K in the Munich Research Reactor. The deformation of the crystal lattice by the defects created was investigated by measuring the lattice parameter change after irradiation and after thermal annealing. A detailed description of the experimental setup is given. Three distinct recovery stages were observed. Comparison with length change and electric resistivity change data shows that all stages are due to recombination of Frenkel defect pairs. New lattice sites are neither created during irradiation nor during thermal annealing of the defects. The ratio of relative lattice parameter change to electric resistivity change was determined to be $1.3 \cdot 10^3$ $(\Omega cm)^{-1}$. For the volume change according to lattice deformation by one Frenkel pair a value (1.4 ± 0.1) atomic volumes was obtained. (auth)

29352 MOESSBAUER EFFECT AND ITS APPLICATIONS. Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). pp 811-919 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

A comprehensive treatment of the Moessbauer effect is presented in seven sections, with references following each section. The topics include: resonance scattering of photons; recoil-free phenomena in low-energy gamma transitions; calculation of the Moessbauer recoil-free fraction; experimental aspects of the Moessbauer effect (source, spectrometers, and detectors); hyperfine interactions in the Moessbauer effect; nuclear isomer shift and quadrupole splitting in ^{57}Fe; and the Moessbauer effect at high pressures and the electronic configurations of iron. (104 references). (L.B.S.)

29353 MAGNETIC ORDERING IN URANIUM COMPOUNDS WITH CRYSTAL STRUCTURES OF ANTI-Cu_2Sb AND PbFCl TYPES. MOLECULAR FIELD APPROXIMATION. Przystawa, J. (Univ. of Wroclaw); Suski, W. Phys. Status Solidi, 20: 451-9(Apr. 1, 1967).

The eight possible types of collinear magnetic structure are determined in the molecular field approximation with the help of Smart's and Bertaut's methods. The Heisenberg isotropic model with five nearest-neighbor exchange integrals is used. The stability conditions are presented in terms of phase diagrams. (auth)

29354 NONIDEAL DIFFUSION OF ARGON IN POTASSIUM CHLORIDE. Schmeling, P. (Kernforschungszentrum, Karlsruhe, Ger.). Phys. Status Solidi, 20: 597-603(Apr. 1, 1967).

The diffusion of ^{39}Ar and ^{41}Ar in single crystals of potassium chloride is studied for the temperature range in which nonideal diffusion is predominant. The results are compared with the analysis of obstructed rare-gas movement by Gaus, and it is shown that all or most of the argon atoms are trapped in crystal defects after irradiation with neutrons. The mechanism for the release of the atoms is sensitive to variations in the irradiation dose and can be related to an activation energy of 2.4 eV only for the lowest doses. (auth)

29355 HARDENING IN IRRADIATED COPPER CRYSTALS. Worzala, F. J. (Westinghouse Electric Corp., West Mifflin, Pa.). Phys. Status Solidi, 20: K81-3(Apr. 1, 1967).

High-purity Cu single crystals were irradiated to an exposure level of 2×10^{18} nvt. Specimens were strained at room temperature and then restrained an additional 2% at 90°K. Etch pitting showed that, after the low-temperature strain, new dislocations were generated in the same glide bands formed during the initial strain. With further low-temperature deformation, band widening was much the same as that observed at room temperature. It is concluded that these results substantiate the depleted-zone theory of irradiation damage proposed by Seeger. (A.G.W.)

29356 EVIDENCE FOR INTERSTITIAL COBALT IN INDIUM BY MOESSBAUER SPECTROSCOPY. Flinn, P. A.; Gonser, U.; Grant, R. W.; Housely, R. M. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 157: 538-9(May 15, 1967).

The Mössbauer effect for ^{57}Fe in indium was measured from helium temperature to near the melting point. Contrary to a previous report, no evidence was found for large anharmonic effects. The high Debye–Waller factor indicates interstitial solution of ^{57}Co in indium metal. (auth)

29357 NUCLEAR QUADRUPOLE COUPLING, KNIGHT SHIFT, AND SPIN–LATTICE RELAXATION TIME IN BERYLLIUM METAL. Barnaal, D. E.; Barnes, R. G.; McCart, B. R.; Mohn, L. W.; Torgeson, D. R. (Ames Lab., Iowa). Phys. Rev., 157: 510-15(May 15, 1967).

The nuclear quadrupole coupling and Knight shift of ^{9}Be have been measured in high-purity beryllium metal at room temperature and at 77°K in magnetic-field strengths up to 25 kOe. The nuclear quadrupole coupling constant is found to have the value $e^2qQ/h = 61.8 \pm 1.8$ kHz, independent of temperature. By contrast,

the best estimate of the lattice contribution to the quadrupole coupling is found to be 68 ± 6 kHz, which implies that the conduction–electron contribution opposes that of the lattice. The Knight shift is found to have the values $K_{Be} = -0.0025 \pm (6)$ at 300°K and $K_{Be} = -0.0035 \pm (6)$ at 77°K (in percent); the uncertainty given is the standard deviation of the measurements. Measurements of the spin-lattice relaxation time at two temperatures indicate that $T_1T = 1.66 \times 10^4$ sec °K with an uncertainty of 10%. These experimental observations can be interpreted in terms of direct-contact and core-polarization contributions, from a predominantly p-like band, which partially cancel to yield the small Knight shift. (auth)

29358 EVALUATION OF THE DEBYE TEMPERATURE OF THORIUM DIOXIDE. Ali, M.; Nagels, P. (SCK-CEN, Mol, Belg.). Phys. Status Solidi, 21: 113-16(May 1, 1967).

The Debye temperature of ThO_2 is calculated using existing data for heat capacity, neutron diffraction, and elastic constants. The resulting values are 259, 268, and 290°K, respectively. Attention is drawn to the existing confusion in the definition of the Debye temperature which involves the inclusion or exclusion of a factor $\sqrt[3]{3}$, depending on how the vibrational units are defined. (auth)

29359 INVESTIGATION OF ANISOTROPIC SLOWING DOWN OF LOW-ENERGY MAGNESIUM ATOMS IN A NaCl SINGLE CRYSTAL AT DIFFERENT TEMPERATURES. Dutta, B. C.; Holtmeyer, G.; Kalus, J. (Technische Hochschule, Munich). Phys. Status Solidi, 21: 291-5(May 1, 1967). (In German).

The nuclear resonance fluorescent (NRF) yield of the 1.37-MeV level of ^{24}Mg, produced by neutron irradiation of ^{23}Na in a NaCl single crystal, is measured as a function of the crystal orientation and the temperature. Dependent on the temperature, the NRF yield from the emission of the γ quanta in the ⟨110⟩ direction is up to 18% higher than for the ⟨100⟩ direction. The temperature dependence is unambiguously due to diffusion processes. Calculations using a hard-sphere model show that at room temperature the equilibrium position of the Mg atom is a body-centered interstitial site. (auth)

29360 THE EFFECT OF SYSTEMATIC REFLECTIONS ON THE (110) EXTINCTION DISTANCE IN MOLYBDENUM. Sheinin, S. S. (Univ. of Alberta, Edmonton). Phys. Status Solidi, 21: 247-56(May 1, 1967).

The dependence of the (110) extinction distance in molybdenum on $\Delta\theta$, the deviation from the exact Bragg condition, has been investigated. The results indicate that near the exact Bragg condition ($0° < \Delta\theta < 0.5°$), the two-beam theory is in good agreement with experiment. For larger values of $\Delta\theta$, the effects of systematic reflections become important. The agreement between the multi-beam theory and experiment is excellent for values of $\Delta\theta$ greater than 1.25°. However, for intermediate values of $\Delta\theta$ where the depth periodicities are complex, neither the two- or multi-beam theories give an adequate description of the experimental results obtained. (auth)

29361 CRITICAL MAGNETIC SCATTERING OF PHONONS. Papoular, M. (CNRS, Orsay, France). J. Phys. (Paris), Colloq., 28: Suppl., C1.140-7(Feb. 1967). (In French).

The magnetic fluctuations and correlations which govern the critical magnetic scattering of phonons, are related, in a random phase type approximation, to the fluctuations and correlations responsible for neutron scattering. The cross sections for direct absorption and scattering of a phonon are obtained. The contribution of these mechanisms to the critical anomalies of thermal resistivity and acoustic attenuation, is calculated and discussed for ferro- and antiferromagnets. (auth)

29362 STUDY OF LOCALIZED VIBRATION MODES OF THE HYDROGEN IN VANADIUM HYDRIDE BY THE INELASTIC SCATTERING OF COLD NEUTRONS. Kley, W.; Peretti, J.; Rubin, R.; Verdan, G. (EURATOM-CCR, Ispra, Italy). J. Phys. (Paris), Colloq., 28: Suppl., C1.26-33(Feb. 1967). (In French).

The scattering of cold neutrons from VH_x, NbH_x, and PdH_x systems was measured at low hydrogen concentrations. The difference between the normalized intensity of the "hydrogen system," and that of the pure host lattice, gives the neutron scattering distribution of the "hydrogen probe" in the host lattice. These intensity distributions show the expected high energy "local modes" of the hydrogen impurity well above the maximum frequency of the host lattice. For VH_x and NbH_x in the α phase, a low energy neutron distribution of a few MeV is also observed, close to the energy of the impinging neutrons. Apart from a certain distortion near the maximum host lattice frequency, in addition the host lattice frequency distribution can be "seen" through the hydrogen "band modes." For Nb, two pronounced peaks are found at energy transfers of 25.9 and 18.3 MeV. They agree reasonably well with recent calculations of the frequency distribution of Nb. (auth)

29363 PHONON LINES IN THE SPECTRA OF COLOR CENTERS IN THE ALKALI METAL HALIDES. Farge, Y.; Parodi, O.; Toulouse, G. (CNRS, Orsay, France). J. Phys. (Paris), Colloq., 28: Suppl., C1.111-17(Feb. 1967). (In French).

The classical and quantum theories for the vibrational structure of the optical spectrum of a localized defect are briefly recalled. One assumes a molecular model, with a single phonon frequency, and one is mostly interested in the linear coupling case. The effect of a continuous phonon spectrum is then considered. A review of the experimental work on zero-phonon lines (symmetry studies, electron–phonon coupling, isotopic shift) is included. (auth)

29364 REACTOR AND FISSION FRAGMENT IRRADIATION EFFECTS ON POTASSIUM DIHYDROGEN PHOSPHATE. Motoc, C. (Gheorghe Gheorghiu-Dej Polytechnic Inst., Bucharest). Rev. Roum. Phys., 12: 269-72(1967).

The effects of reactor and fission fragment irradiation on KH_2PO_4 single crystals were examined. With the aid of the metallographic and electron-microscope techniques important structural changes were observed. Fission fragment effects such as clusters of lines or loops were observed without employing a special technique. By using the chemical etching technique for the reactor-irradiated crystals, dislocations and alterations in growth layers were seen. (auth)

29365 X-RAY PRODUCTION OF VACANCIES IN KCl AT LOW TEMPERATURES. Behr, A.; Peisl, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Status Solidi, 21: K9-10(May 1, 1967).

KCl crystals were x irradiated at liquid He and N_2 temperatures, and the growth of α and F centers was determined from optical absorption. Irradiation at liquid He temperature followed by warming to liquid N_2 temperature gave the same curve as irradiation at liquid N_2 temperature, and it is concluded that the same primary process of defect formation holds at both liquid He and N_2 temperatures. (D.L.C.)

29366 LOW ENERGY X-RAY MASS ABSORPTION COEFFICIENTS FROM 1.49 TO 15.77 keV FOR SCANDIUM, TITANIUM, VANADIUM, IRON, COBALT, NICKEL, AND ZINC. Carter, R. W.; Rohrer, R. H.; Carlton, W. H.; Dyer, G. R. (Emory Univ., Atlanta). Health Phys., 13: 593-9(June 1967).

Mass absorption coefficients were measured for photon energies from 1.49 to 15.77 keV with an average standard deviation from the mean of 1.2 per cent. A high-intensity x-ray beam was provided by a partially evacuated Bragg crystal spectrometer. The absorbers were cold rolled from spectroscopic grade material, with thickness determined by the weight-area measurement method. An empirical equation relating photon energy and mass absorption coefficient is proposed for photon energies between L- and K-absorption energies of the absorber. This equation is used to predict values of mass absorption coefficients for Pb, Sn, Cu, and Ca. (auth)

29367 RELATION BETWEEN LUMINESCENCE AND MOTION OF CHARGES IN ALKALI METAL HALIDE PHOSPHORS. Mikhal'chenko, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1436-8(Sept. 1966). (In Russian).

An apparatus is described for the investigation of alkali halide phosphors by means of the Bergmann–Putseyko capacitor technique. In this equipment, a 0.5 to 3.0-mm thick, 13-mm-diameter plate of the crystal phosphor under investigation is mounted in the 0- to 30-kV/cm electric field between two nickel grids. Luminescence can be excited by radiations from a radioactive source and stimulated by pulses of F-band light, or the luminescence can be excited by pulsed ultraviolet radiation or by mechanically pulsed α and β radiation. The temperature of the specimen can be varied from –180 to 280°C. The stimulating radiation falls onto one face of the specimen through one of the nickel grids, and the luminescence from the other face of the specimen is detected with a photomultiplier. Signals from one of the grids and from the photomultiplier are amplified in identical preamplifiers having equal long (0.4 sec) time constants and are displayed on a dual-trace oscilloscope. By comparing the two signals, one can draw conclusions concerning the motions of charges in the phosphor and their relation to the luminescence. A number of scattered results are mentioned to illustrate the possibilities of the equipment. In addition to its use as a research tool, the equipment can be employed for analytical control of defects and detection of traces of certain impurities (in particular of Tl^+) that are difficult to detect otherwise. It was found that over a wide range of temperatures, stimulating intensities and other conditions, the duration of the electrical signal resulting from pulsed stimulation of an alkali halide phosphor in the F band is longer than that of the luminescence signal. From this it is concluded that there are either several kinds of F centers, or destruction of an F center results in release of holes from V centers. The first alternative is regarded as the more

likely because the temperature dependences of the two signals were found to vary in a parallel manner under the influence of different activators and activator concentrations. (ATD)

29368 FURTHER REMARKS CONCERNING TWO MECHANISMS OF PHOTOSTIMULATED ELECTRON EMISSION FROM IONIC CRYSTALS. Belkind, A. I.; Bichevin, V. V.; Kalendarev, R. I.; Kyaembre, Kh. F. (Inst. of Physics, Riga. Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1448-50(Sept. 1966). (In Russian).

The following two mechanisms for photostimulated electron emission from alkali halide crystals are briefly discussed: (1) direct photoionization of an F center with the escape from the crystal of the resulting energetic photoelectron, and (2) photothermal ionization of a center and escape from the crystal as a result of thermal fluctuations of the thermal electron thus produced. The potential barriers W against escape of an electron from alkali halide crystals are calculated as the difference between the photoelectric threshold and the width of the forbidden gap from relevant data in the literature. Values of W for NaCl and KCl were also calculated from the temperature dependence of electron emission from previously x-irradiated crystals stimulated in the F and E bands by invoking mechanism (2). The W values found in this way were systematically lower than those calculated directly from the photoelectric threshold. It is hypothesized that this difference is due to the fact that the photoelectric effect was investigated in vacuum, whereas the emission due to stimulation in the F and E bands was measured in a gaseous atmosphere. This hypothesis was tested by measuring the photostimulated luminescence and electron emission in vacuum of x- or γ-ray excited KCl:Tl and KBr:Tl crystals. It was found that a maximum in the F band in the stimulation spectrum for photostimulated electron emission, which is characteristic of process (2), was present only when the measurements were made in a gaseous atmosphere (air + alcohol vapor, or methane). It is assumed that the presence of an atmosphere results in contamination of the surface and therefore in a lower value of W, which makes it possible for mechanism (2) to contribute appreciably to the electron emission. (ATD)

29369 MICROSPECTROPHOTOMETRIC INVESTIGATION OF THE INFLUENCE OF DISLOCATIONS ON THE STABILITY OF F CENTERS IN NaCl CRYSTAL PHOSPHORS. Sidlyarenko, V. I.; Spikin, V. I. (Osh State Pedagogical Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1477-8(Sept. 1966). (In Russian).

The microspectrophotometric technique was used to investigate the thermal bleaching of F centers in regions with linear dimensions of the order of 0.01 cm in x-irradiated NaCl crystals grown by the Kyropoulos technique and containing 0.2 mole % Ag. The investigation was undertaken because a correlation had previously been found between the thermal stability of F centers and the density of dislocations in individual alkali halide crystals and it was desired to determine whether this correlation would extend to different regions of the same crystal. Thermal bleaching of the F centers was found to take place in two stages. The temperature at which the first (low-temperature) stage of the thermal bleaching occurred varied from region to region and was higher in the regions with the higher dislocation densities, while the temperature at which the second stage took place was the same (from about 475 to 575°K) in all the regions. It is concluded that the presence of dislocations contributes to the low-temperature thermal stability of F centers, but not to the high-temperature thermal stability thereof. A brief explanation of the observed correlation is given in terms of the ionic thermal bleaching mechanism of Lukantsever and Zaitov (Izv. Akad. Nauk SSSR. Ser. Fiz., 25: 473(1961)). (ATD)

29370 CONCERNING THE PARALLELISM BETWEEN THE TEMPERATURE DEPENDENCE OF THE ROENTGENOLUMINESCENCE AND OPTICAL FLASH BRIGHTNESS FOR ALKALI METAL HALIDE PHOSPHORS. Krongauz, V. G. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1420-3(Sept. 1966). (In Russian).

Measurements were made of the temperature dependences of the roentgenoluminescence and the F flash of Ni-, Cu-, In-, Pb-, and Tl-activated NaCl, KCl, KBr, and KI phosphors and of an NaCl phosphor containing both Cu and Ni. The F flash was elicited by illuminating the uniformly heated specimen with a pulse of light in the F absorption band. To measure the roentgenoluminescence the specimen was first excited by 15-min irradiation at 100°K with x rays. The specimen temperature was then raised at the rate of 0.28 degree/min and the specimen was periodically stimulated by 1-sec x-ray pulses. The brightness of the thermoluminescence was subtracted from the total brightness during stimulation. Measurements were continued up to temperatures so high that the F flash no longer appeared, (400 to 500°K). The results are presented graphically. The temperature dependences were found to be complex and to vary considerably from specimen to specimen, but there was a marked parallelism between the roentgenoluminescence and F flash temperature dependences for a given specimen. At the temperature at which the F flash intensity dropped rapidly and vanished, the roentgenoluminescence intensity also dropped rapidly with increasing temperature, although it did not vanish; this was the case not only in NaCl:Ni, but also in NaCl:Cu, in which there is a wide temperature range between vanishing of the F flash and final disappearance of the F centers. The temperature dependences of the two luminescence effects were also parallel in the specimen containing two activators, but they differed considerably depending on whether they were measured in the 630 mμ Cu band or the 360 mμ Ni band. An explanation of the results is given on the basis of the hypothesis that the luminescence is due to electron recombination at "activator + hole" centers, the concentration of which is determined by the thermal dissociation of V centers. It is believed that it would be difficult to explain the results on the basis of an exciton luminescence mechanism. (ATD)

29371 INVESTIGATION OF THE ROENTGENOLUMINESCENCE, ABSORPTION, AND EMISSION SPECTRA OF NaCl:Eu SINGLE CRYSTALS. Parfianovich, I. A.; Ivakhnenko, P. S.; Shuraleva, E. I. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1416-19(Sept. 1966). (In Russian).

The luminescence and absorption of NaCl:Eu crystals grown from a melt was investigated in order to obtain information concerning the nature and conversion of the luminescence centers. The absorption spectrum of crystals that had been heated to 350°C had peaks at 240, 340, and 370 mμ. Illumination in these bands excited luminescence peaking at 425 mμ. All three of these absorption bands are ascribed to the same type-I centers. In annealed crystals there were found centers of a second type (type-II), characterized by absorption peaks at 260, 272, and 330 mμ and a broad luminescence spectrum peaking at 455 mμ, which was strongly stimulated by illumination in the 272 mμ band but not by illumination in the 260 mμ band. When the specimens were irradiated with x rays there was first a buildup of the luminescence, then a decline. The decline is ascribed to transformation of the luminescence centers by the x rays. Induced absorption peaks were found at 272, 312, 410, and 570 mμ. The 272 and 312 mμ induced absorption bands did not appear in annealed crystals and no emission was observed from the induced activator centers in any of the specimens. The roentgenoluminescence intensity exhibited a complex temperature dependence, first decreasing as the temperature was raised above room temperature and then increasing and passing through two maxima at about 150 and 320°C. The 150° maximum was found to be due to increase of the buildup light sum. From the temperature dependence of the absorption spectra, it is concluded that the presence of the 320°C maximum is due to conversion of type-I centers to type-II centers at temperatures between 160 and 260° and their subsequent re-establishment at higher temperatures. (ATD)

29372 EFFECT OF BUILDUP OF THE F FLASH AND ROENTGENOLUMINESCENCE IN KI:Tl PHOSPHORS. Parfianovich, I. A.; Krongauz, V. G. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1414-15(Sept. 1966). (In Russian).

The specimens were irradiated with x rays for 15 minutes at 105°K and the intensity of the F flash was recorded both before and after the specimen had been heated to 133°K and again cooled to 105°. The specimen was again irradiated with x rays and the whole cycle was repeated several times. Heating the specimen to 133° and subsequently cooling it to 105° was found to increase the intensity of the F flash as well as the initial intensity of the luminescence during the subsequent x irradiation. When the specimen was irradiated with F-band light instead of x rays, heating to 133° and subsequent cooling did not enhance either the F flash or the x-ray flash. The observed effects of heating are ascribed to dissociation at 133°K of V_k centers and the entrapment of the holes thereby released in the vicinity of Tl^+ ions with the formation of Tl^+ p centers. (ATD)

29373 RADIOLUMINESCENCE OF PHOSPHORUS-ACTIVATED ALKALI METAL HALIDE CRYSTALS. Plachenov, B. T.; Avdonin, V. P.; Mikhal'chenko, G. A.; Smagin, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1411-13(Sept. 1966). (In Russian).

Phosphorus-activated NaBr, KCl, KBr, KI, and CsBr crystals were obtained by growing the crystals in a phosphorus vapor atmosphere. The crystals had an absorption band in the 280- to 290-mμ region that disappeared after a 2-hour anneal at 600°K. From this it is concluded that the phosphorus entered the crystals in the nonionized state. Attempts to synthesize crystals containing oxidized phosphorus were unsuccessful. The phosphors exhibited photo- and radioluminescence with an afterglow that lasted

for milliseconds. The temperature dependence of the radioluminescence was investigated in some detail. The specimens were stimulated with radiations from radioactive β sources at one temperature, were annealed at a second higher temperature, and were again stimulated with the same radiations at a third temperature. It was possible greatly to enhance the radioluminescence by this procedure, sometimes by a factor of 100. The enhanced luminescence could also be stimulated by radiation in the F band. The luminescence was largely concentrated in two bands located at 370 and 430 mμ. The decay of the 370-mμ afterglow was such as to indicate that this luminescence band is due to a "bimolecular" process. The two luminescence bands behaved differently, and possible mechanisms that might account for them are discussed. It is concluded that the 430 mμ-luminescence is due to hole recombination, and the 370-mμ luminescence, to electron recombination. The afterglow capability of the phosphorus-activated luminophors is ascribed to accumulation of holes at luminescence centers of two types. A certain increase in the luminescence intensity in the 430-mμ band during afterglow is ascribed to transfer of excitation energy from centers of one type to those of the other type. (ATD)

29374 RADIOLUMINESCENT AND STORAGE PROPERTIES OF ALKALI METAL HALIDE CRYSTAL PHOSPHORS. Mikhal'chenko, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1409-10 (Sept. 1966). (In Russian).

Measurements were made of the absolute luminescence yields (both prompt and stored) of NaCl, KCl, KBr, KI, NaI, CsBr, and CsI crystal phosphors activated by Ag, Tl, In, Eu, or Yb and excited at different temperatures between +250 and −180°C with α, β, or γ rays. Photodissociation of trimethylphenyl leucocyanide dyes was employed to measure the luminescence yields. The luminescence yields during excitation and the stored light sums for excitation at 25 and −160°C by α or β particles are tabulated for 18 different phosphors. For most of the phosphors, the total recovered stored light sum was the same when its emission was thermally stimulated as when it was stimulated by irradiation in the F band, but for a few of the phosphors the thermostimulated recovery greatly exceeded the F-band stimulated recovery, and for a few others, the reverse was the case. Introducing lattice defects by grinding the crystals to a powder greatly reduced the luminescence efficiencies of some of the phosphors, including KI, Eu, and significantly increased the efficiency of others, including thallium-activated chloride–bromide and chloride–iodide hybrids. Some of the phosphors, in particular, NaCl: Eu and KCl: Eu, are suitable for use in dosimetry, losing only 40% of the stored light sum when stored for 300 hours. For some of the materials (KBr: Tl and KI: Tl) the total luminescence yield was almost independent of the excitation temperature, whereas the stored light sum and the luminescence yield during excitation both depended strongly on the excitation temperature. For excitation with α particles the luminescence yield was lower and the temperature dependence of the luminescence yield was weaker than for excitation with β or γ radiation. (ATD)

29375 TEMPERATURE STABILITY OF SELF-TRAPPED HOLES IN SOME ALKALI METAL HALIDE SINGLE CRYSTALS. Pung, L. A.; Khaldre, Yu. Yu. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1446-7(Sept. 1966). (In Russian).

EPR absorption was used to measure the concentration of Cl_2^- centers at temperatures from 100 to 300°K in x-ray-excited pure and Ag-, Pb-, and Tl-activated NaCl and KCl crystals. The crystals were excited by x rays at 77°K. The results are presented as curves showing for the different crystals the relative number of Cl_2^- centers as a function of temperature, and are discussed briefly. Release of holes from traps was found to take place in NaCl and NaCl: Ag crystals at the same temperature (beginning at about 150°K), and in NaCl: Pb at some 10° higher. In the activated KCl crystals, detrapment of holes took place at temperatures ranging from 190 to 210°K. Decrease of the Cl_2^- center concentration in pure KCl began at 125°K. The present results cannot be reconciled with the finding of Delbecq, Smaller, and Yuster (Phys. Rev., 111: 1235(1958)) that the delocalization of V_k centers in pure KCl takes place at 130°K. No changes (except in intensity) in the Cl_2^- EPR spectrum were observed at temperatures below 220°K; the hyperfine structure of the EPR line broadened at higher temperatures, indicating a change in the surroundings of the holes, i.e., their detrapment. The decrease in the Cl_2^- center concentration with increasing temperature at lower temperatures is ascribed to recombination with electrons released from electron traps. The Cl_2^- centers were found to transform at certain temperatures into new centers that were more stable; this resulted in a stepwise shape of the concentration–temperature curve. The temperature at which self-trapped holes were freed did not depend strongly on the impurities in the crystals. (ATD)

29376 ELECTRON PARAMAGNETIC RESONANCE INVESTIGATION OF ELECTRON AND HOLE PROCESSES IN KCl:Ag AND NaCl:Ag CRYSTALS. Pung, L. A.; Khaldre, Yu. Yu. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1443-5(Sept. 1966). (In Russian).

EPR absorption was measured at temperatures from 100 to 400°K in KCl: Ag and NaCl: Ag crystals that had been excited by irradiation with x rays at 77°K. Strong EPR absorption by Ag^{2+}, Cl_2^-, and $BrCl^-$ centers was observed in both materials, and EPR absorption by Ag^0 centers was observed in the KCl: Ag, but not in the NaCl: Ag crystals (bromine was present as an impurity in all the crystals). The Cl_2^- centers were most prominent in the low temperature portion of the investigated temperature range, the $BrCl^-$ centers were most concentrated at the middle temperatures, and the Ag^{2+} centers were most concentrated near the high-temperature portion of the range. The Ag^0 center concentration in the KCl: Ag crystals decreased monotonically with increasing temperature over the entire investigated range. The width and shape of the Ag^0, Ag^{2+}, and $BrCl^-$ EPR absorption lines remained constant over the full temperature range, but the Cl_2^- line in KCl: Ag increased in width with increasing temperature, beginning at about 220°K. It is concluded that the relaxation in KCl: Ag at 230 to 270°K is due to a hole process, and that the relaxation in KCl: Ag at 300 to 380°K and in NaCl: Ag at 200 to 250°K is due to an electron process. The failure to observe Ag^0 centers in NaCl: Ag is ascribed to broadening of the EPR line with consequent reduction of its intensity below the noise level as a result of interaction of the unpaired electrons in the shallow activator traps with the surroundings. (ATD)

29377 QUENCHING AND STIMULATION OF THE ELECTROLUMINESCENCE OF ZnS:Cu PHOSPHORS BY IRRADIATION. Boiko, L. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1470-2(Sept. 1966). (In Russian).

An investigation was made of the luminescence intensity of ZnS: Cu and ZnS: Cu: Mn electroluminophors under simultaneous excitation by an electric field and by ultraviolet radiation, x rays, or γ rays. Intense ultraviolet irradiation increased the electrical conductivity of the specimen by an order of magnitude and had a quenching effect on the luminescence, i.e., the ratio $z = (B_e + B_p)/B_{ep}$ was greater than unity, where B_e is the electroluminescence brightness, B_p is the photoluminescence brightness, and B_{ep} is the luminescence brightness in the simultaneous presence of both stimuli. X and γ irradiation also increased the conductivity, but not so greatly as did optical irradiation, and enhanced the electroluminescence. The enhancement of the electroluminescence decreased with increasing x or γ dose. It is suggested that the observed phenomena are due to competition between radiative trapping of conduction electrons and nonradiative entrapment of conduction electrons in three-body Auger-like processes in which the energy that would otherwise be radiated is transferred to a second conduction electron: intense irradiation greatly increases the conduction electron concentration, thus favoring the nonradiative Auger transitions and quenching the luminescence, and irradiation with penetrating x or γ rays slightly increases the conduction electron concentration and enhances the luminescence. (ATD)

29378 ELECTROROENTGENOLUMINESCENCE OF A ZnS:Cu PHOSPHOR. Kolomoitsev, F. I.; Ivanii, G. M.; Sidorenko, S. M. (Dnepropetrovsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1458-60(Sept. 1966). (In Russian).

An investigation was made of the luminescence of a ZnS: Cu phosphor under simultaneous excitation by x irradiation and an alternating electric field. The powdered phosphor, mixed with a binder, was deposited on the conducting surface of a glass plate and coated with an aluminum film electrode. Electroluminescence was excited by application of alternating potentials of 30 to 80 V at frequencies from 0.05 to 200 kHz between the conducting glass substrate and the aluminum electrode, and roentgenoluminescence was excited by radiations from a 50-kV x-ray tube incident on the aluminized face of the specimen. The luminescence was observed through the glass substrate with a photomultiplier. The difference $D = B_{er} - (B_e + B_r)$, where B_e is the luminescence brightness under electric field excitation alone, B_r is the brightness under x-ray excitation alone, and B_{er} is the brightness under simultaneous electric and x-ray excitation, could be either positive or negative, depending on the strengths of the two excitations and the frequency of the electric field. For fixed x-ray excitation and frequency, D was negative for small exciting voltages V and increased with increasing V; for fixed x-ray excitation and V, D was small or negative at low frequencies and increased with increasing frequency. The spectral distributions of B_e, B_r, and B_{er} were recorded. The maximum of B_e occurred at a longer wavelength than that of B_r, and D was small or negative at the short wavelengths where $B_e < B_r$, and positive at the longer wavelengths where $B_e > B_r$. It is concluded that D is positive when the electroluminescence

brightness exceeds the roentgenoluminescence brightness; that positive values of D are due to enhancement of the electroluminescence brightness by the x-ray excitation; and that rather large positive values of D can be achieved. Electroluminophors with large values of D may find technical application as x-ray screens or in other devices. (ATD)

29379 OPTICAL AND THERMAL ELECTRONS AND PHOTOSTIMULATED LUMINESCENCE IN KCl:Tl. Kyaembre, Kh. F.; Okk, M. F.; Yaek, I. V. (Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1451-3(Sept. 1966). (In Russian).

Investigations (Okk and Yaek, Izv. Akad. Nauk SSSR. Ser. Fiz., 29: 46(1965)) on photostimulated luminescence in ionic crystals were extended to include stimulation by radiation on the short-wavelength side of the F band. The luminescence excitation spectra of x-ray-excited KCl: Tl crystals were recorded at 300 and 100°K for stimulating photon energies from 1.6 to 4 eV. Four peaks were observed in the spectra: the F-band peak at 2.2 eV, the K-band peak at 2.75 eV, the Tl^0-band peak at 3.3 eV, and a peak of unknown origin at 3.8 eV. The temperature dependences of the luminescence intensity for stimulation in the F, K, and Tl^0 bands were separately recorded for the temperature range from 80 to 300°K. The intensity of the F flash decreased monotonically with decreasing temperature; that of the K flash was almost temperature independent; and the intensity of the Tl^0 flash increased somewhat with decreasing temperature. The temperature independence of the K-flash intensity is in good accord with the findings of Kanzaki, Ninomiya, and Kido (J. Phys. Chem. Sol., 22: 309(1961)) on photostimulated conductivity. It is concluded from the present results and different findings of other authors that the K flash is recombination luminescence in which true optical (hot) electrons, rather than thermal electrons, participate. The reason for the increase of the Tl^0-flash intensity with decreasing temperature is not known. (ATD)

29380 EFFECT OF AN ELECTRIC FIELD ON THE LUMINESCENCE OF KI:Tl PHOSPHORS. Pologrudov, V. V. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1542-4 (Sept. 1966). (In Russian).

It was previously found that an electric field tends to quench the photoluminescence of a KI: Tl phosphor excited in the activator absorption bands and tends to enhance the roentgenoluminescence, and have hypothesized that the quenching action is due to an external quenching mechanism and that the enhancement of the roentgenoluminescence is due to reduction by the field of the recombination losses. Further experimental results supporting these hypotheses are presented. It was found that the roentgenoluminescence intensity decreases with increasing temperature from room temperature to 300°C. At temperatures above 50°C (but not at lower temperatures), the relative roentgenoluminescence intensity of a heavily x-irradiated specimen was higher than that of an unirradiated one; this is ascribed to thermal dissociation of radiation-induced defects. The enhancement of the roentgenoluminescence by the action of a 10^5V/cm 400-Hz field decreased with both increasing temperature and increasing activator concentration, and at high temperatures the electric field tended to quench the roentgenoluminescence of specimens having high activator concentrations. The most rapid decrease of the enhancement factor with increasing temperature took place in the same temperature interval from 30 to 80° as did the most rapid drop in the roentgenoluminescence intensity. The interpretation of these findings is discussed. (ATD)

29381 ELECTRON–NUCLEAR DOUBLE-RESONANCE STUDY OF AN H CENTER IN LiF. Dakss, M. L. (Columbia Univ., New York); Mieher, R. L. Phys. Rev. Lett., 18: 1056-8(June 12, 1967).

An ENDOR study of the H center produced by x rays in reagent-grade LiF shows the defect to be a F_2^- molecule located on a single lattice site but associated with a Na^+ impurity. Attempts to produce isolated H centers in high-purity LiF were unsuccessful. (auth)

29382 EFFECT OF TEMPERATURE ON THE ANOMALOUS TRANSMISSION OF X RAYS IN GERMANIUM. Ghezzi, C.; Merlini, A.; Pace, S. (CCR-EURATOM, Ispra, Italy). Nuovo Cim. (10), 49B: 58-65(May 11, 1967).

Absolute measurements of integrated intensities, diffracted in anomalous transmission through perfect single crystals of Ge were done in the temperature interval 80 to 500°K. The intensities of the transmitted and reflected beams were measured for the {220} reflection with MoKα($\mu_0 t \approx 38$) and CuKα radiations ($\mu_0 t \approx 44$). By comparing the plots of the logarithm of the measured intensities vs. temperature with those calculated for different Debye temperatures, Θ was found to be (283 ± 3)°K with both x-ray wavelengths. The independence of Θ on the wavelength can be considered as a proof that the K and L electrons of the atom vibrate as a rigid body. The absolute integrated intensities measured with CuKα radiation give a value of ϵ_0 (the ratio between the imaginary parts of the form factor for the scattering and forward directions) equal to 0.994 ± 0.0015 which is in very good agreement with the calculated value. (auth)

29383 EVIDENCE FOR DAMAGE REGIONS IN Si, GaAs, AND InSb SEMICONDUCTORS BOMBARDED WITH HIGH-ENERGY NEUTRONS. Bertolotti, M.; Papa, T.; Sette, D.; Vitali, G. (Univ., Rome. CNR, Rome). J. Appl. Phys., 38: 2645-7(May 1967).

Evidence is reported for the existence of damage regions in Si, GaAs, and InSb irradiated with monoenergetic 14-MeV neutrons. The regions were revealed by using a chemical etch and observing carbon replicas of the surface with an electron microscope. (auth)

29384 DEFECTS IN THE COMPOUND Bi_2Te_3 CAUSED BY IRRADIATION WITH PROTONS. Chaudhari, P.; Bever, Michael B. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 38: 2417-22(May 1967).

Single-crystal foils of the compound Bi_2Te_3 were irradiated with 7.5-MeV protons at two levels of flux to the same integrated dose of 5.5×10^{18} protons/cm^2. The specimens were examined by transmission electron microscopy. After irradiation with a flux of 1.8×10^{13} protons/cm^2 sec, clusters of point defects ranging in size from approximately 50 to 250 Å were observed. These clusters annealed out during examination in the electron microscope. After irradiation with a flux of 3.0×10^{13} protons/cm^2 sec, clusters of interstitial atoms and clusters of vacancies could be distinguished. Hexagonal areas were observed after irradiation with the higher flux. Irradiation also promoted the rearrangement of dislocations. Segments of dislocations intersected the surface of the specimens, and some dislocations acquired a jagged appearance. (auth)

29385 X-RAY STUDY OF PROTON-INDUCED DISORDER IN Cu_3Au. Kosaki, M. (Univ. of California, Berkeley); Smith, Harold P. Jr.; Khan, J. M.; Potter, D. L.; Worley, R. D. Contract W-7405-eng-48. J. Appl. Phys., 38: 2497-9(May 1967). (UCRL-70058).

Measurement of fundamental and superlattice x-ray-diffraction lines as a function of integrated proton-bombardment current has been used to determine induced disorder in the surface layers of fully ordered polycrystalline targets of Cu_3Au. It is shown that a proton range for induced disorder and the number of disordered atoms created per proton can be inferred from the data. (auth)

29386 EFFECT OF IMPURITIES ON THE ANNEALING BEHAVIOR OF IRRADIATED SILICON. Hirata, Mitsuji (Osaka Univ.); Hirata, Masako; Saito, Haruo; Crawford, James H. Jr. J. Appl. Phys., 38: 2433-8(May 1967). (ORNL-P-2747).

The effect of impurities on the annealing behavior of irradiated silicon was studied through an investigation of isothermal annealing of minority carrier lifetime in silicon crystals containing phosphorus, arsenic, antimony, or bismuth in the temperature range 100 to 180°C. The activation energy for the annealing of a vacancy–impurity complex increased with increasing atom size of the dopant. The values are 0.93, 1.27, 1.84, and 2.22 eV. The frequency factor was also found to be dependent on impurity as well as concentration of the complex. The variation of these parameters is discussed in terms of the lattice strain associated with impurity atoms that have a larger covalent radius than silicon. (auth)

29387 STUDY OF ELECTRON-BEAM AGING OF PHOSPHORS USING MASS SPECTROSCOPY. Grosso, P. F.; Taylor, R. C.; Ward, S. A. (CBS Labs., Stamford, Conn.). J. Appl. Phys., 38: 2697-8(May 1967).

Evidence that the aging of phosphors in cathode-ray tubes is caused by a compositional change was obtained by mass-spectroscopic analysis of the gases in operating tubes containing phosphors of calcium magnesium silicate, zinc magnesium fluoride, and zinc cadmium sulfide. In each tube a significant increase in the partial pressure of a mass corresponding to a volatile element unique to the phosphor composition (mass 32 in the silicate phosphor, mass 19 in the fluoride phosphor, and mass 16 in the sulfide phosphor) was observed upon electron bombardment. Permanent removal of the volatile element may be accomplished by capture of this element by other components of the tube, notably carbon. (A.G.W.)

29388 X-RAY AND NEUTRON DIFFRACTION. Bacon, G. E. Oxford, Pergamon Press, 1966. 368p. 35s.

Section headings are as follows: crystal form and crystal symmetry; experimental demonstration of crystal diffraction; internal crystal symmetry and space groups; principles of crystal structure determination with x rays; Fourier analysis of crystal structure; applications and limitations of x-ray diffraction; diffraction of neutrons; magnetic scattering of neutrons; and inelastic neutron scattering. Reprints of classical papers on the subject are included, ranging from 1912 to 1952. (UK)

Theoretical Physics

Refer also to abstract 28268.

29389 (NP-16735) SCHROEDINGER EQUATION FOR QUANTUM FIELDS WITH NONLINEAR NONLOCAL SCATTERING. Glimm, James (Aarhus Univ. (Denmark). Matematisk Institut). Jan. 1966. 47p. Dep.

Hamiltonian operators of the form $H = H_0 + V$ are considered where H_0 is the Hamiltonian for a free field and V is a polynomial in the creation annihilation operators. The Lie algebra formed by such Hamiltonian operators is studied, and the Schroedinger equation for these Hamiltonian operators is solved. Extensive use of topology is made in defining the V operators and their domains and in the solution of the Schroedinger equation. (M.O.W.)

29390 (SC-M-67-326) LECTURES ON CONTINUUM MECHANICS. Bowen, Ray M. (Sandia Corp., Albuquerque, N. Mex. Louisiana State Univ., New Orleans). May 1967. Contract AT(29-1)-789. 308p. Dep. CFSTI.

Lecture notes are presented in order to obtain an understanding of the basic axioms of continuum mechanics in a framework that is stripped of special constitutive equations and to obtain an understanding of nonlinear materials and their relationship to classical linearized theories. (J.H.M.)

29391 (WVT-6718) PATH INTEGRALS IN POLAR COORDINATES: CHARGED PARTICLES IN A UNIFORM MAGNETIC FIELD. Inomata, Akira (Watervliet Arsenal, N. Y. Benet Labs.). Feb. 1967. 33p. CFSTI.

The statistical density matrix for a system of charged particles in a uniform magnetic field is derived by Feynman's path integral method. The integrations over all paths are directly carried out by use of cylindrical coordinates. As limiting cases, the density matrices for free particles, rigid rotators, and harmonic oscillators are also discussed. (auth)

29392 RELATIVISTIC WAVE EQUATIONS. Tumanov, V. S. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 151-8(1966). (In Russian).

A method for deriving relativistic wave equations in a matrix form for high-spin particles is described. The magnitudes of matrix $\beta\nu$ constants, the inversion operator matrix, and scalar matrix in the current expression for the particles with spins 0, ½, 1, ³/₂, and 2 were derived. (tr-auth)

29393 NOTES ON THE QUANTUM THEORY OF TRANSITION AND TIME-DEPENDENT PERTURBATION. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Z. Phys., 203: 13-16(1967).

It is shown that the introduction of the time-dependent perturbation sharply at an instant, is redundant to obtain the usual expression for the transition rates between states, provided the initial state is an incoherent mixture of the unperturbed states. (auth)

29394 GEOMETRICAL INTERPRETATION OF THE THEORY OF GRAVITATION IN FLAT SPACE. Mittelstaedt, P.; Barbour, J. B. (Univ., Cologne). Z. Phys., 203: 82-90(1967).

In the framework of the flat space-time approach to gravitational theory the equations of motion of point particles are derived from a suitable Lagrangian. Attention is paid to the distinction of the different worldline parameters in Minkowskian and Riemannian space-time. It is shown that the world lines of point particles are geodesics in a Riemannian space-time and permit a consistent geometrical interpretation of the theory. (auth)

29395 VARIATION OF THE MAGNETIC MOMENT OF A CHARGE IN A MIXED FIELD (STATIC MAGNETIC FIELD + HIGH FREQUENCY FIELD). Canobbio, Ernesto; Collet, Roland (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 428-31(Feb. 6, 1967). (In French).

The basic properties of the acceleration of an electron-ion pair in the case where the high-frequency field does not depend on space are established. The calculation presented constitutes an improvement of the analytical solution previously proposed. (tr-auth)

29396 APPLICATION OF GENERAL-RELATIVITY METHODS TO THE STUDY OF LONG-PERIOD COMET TRAJECTORIES. Aver'yanova, T. V.; Stanyukovich, K. P. Soviet Astron. AJ (Engl. Transl.), 10: 1042-5(May-June 1967).

Translated from Astron. Zh., 43: 1301-5(Nov.-Dec. 1966).

A treatment is given of the motion of a particle (a comet) in the Schwarzschild field of the Sun, as perturbed by a medium with low uniform density. The perturbation is considered in a quasi-Newtonian approximation. Close to the sun, the perturbing medium consists of interplanetary gas and dust; at large distances, of the gas and dust of the interstellar medium. The energy densities of both the electromagnetic and gravitational fields of the Galaxy in the solar neighborhood are taken automatically into account, since their values are comparable with each other and with the energy density of the gas-dust material of the interstellar medium. Unlike a purely Newtonian treatment of the influence of the perturbing medium, this formulation of the problem enables one simultaneously to identify the Schwarzschild displacement in the perihelion of the comet orbit, and the additional displacement induced by the gravitating matter of the perturbing medium contained within the sphere passing through the comet at any given time. The additional perihelion displacement considerably exceeds the Schwarzschild value for comets with large aphelion distances; it can attain several tens of minutes for one revolution of the comet. (auth)

29397 COMPUTER PROGRAMS FOR CALCULATING GENERAL-RELATIVISTIC CURVATURE TENSORS. Fletcher, John G.; Clemens, Reg; Matzner, Richard; Thorne, Kip S.; Zimmerman, Barbara A. (Univ. of California, Livermore. Univ. of Maryland, College Park. California Inst. of Tech., Pasadena). Astrophys. J., 148: L91-2(May 1967).

Computer programs were written and are available for calculating analytically the Riemann tensor, $R^{\alpha}_{\beta\gamma\delta}$, the Ricci tensor, R^{α}_{β}, the Einstein tensor, G^{α}_{β}, and the equations of motion, $T^{\alpha}_{\alpha;\beta} = 0$, corresponding to any metric tensor and any stress-energy tensor. (auth)

29398 KINETIC EQUATIONS FOR A NONUNIFORM RELATIVISTIC ELECTRON GAS. de Gottal, Ph. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 52: 1094-1117(1966).

A detailed account is given of the statistical derivation of the hydrodynamic equations for an imperfect relativistic electron gas. The method developed is a straightforward generalization of the one used in the nonrelativistic case. (W.D.M.)

29399 CONSERVATION LAWS IN EINSTEIN'S THEORY OF GRAVITATION. Fikhtengol'ts, I. G. (Leningrad Inst. of Fine Mechanics and Optics). Dokl. Akad. Nauk SSSR, 170: 79-80 (Sept. 1, 1966). (In Russian).

The correlation between the conservation laws in Einstein's gravitational theory and the properties of Lagrange functions in the gravitational field were investigated, starting from the Lagrangian form of the gravitational equation which includes a fundamental tensor, a determinant related to a component of the fundamental tensor, Einstein's gravitational constant and the mass tensor. Making use of the transformation law of the Lagrange function and substituting certain arbitrary constants in the equations, new equations were obtained. They were obviously derived from Einstein's conservation laws, including those investigated by L. D. Landau and P. G. Bergmann. (TTT)

29400 CORRELATION BETWEEN THE CONTRAVARIANT AND COVARIANT EINSTEIN COORDINATE SYSTEM AND ITS PHYSICAL MEANING. Raab, Ivo (Univ., Innsbruck). Acta Phys. Austr., 25: 62-72(Apr. 1967). (In German).

By introducing non-holonomic covariant coordinates as a supplement to the contravariant coordinates, which are generally used, it becomes possible to assign physical meaning to the components of both the covariant and contravariant fundamental metric tensors of the general relativity theory. The relation between these two coordinate systems is revealed, the physical meaning of this relation analyzed, and the special case of Gaussian coordinates discussed. (auth)

29401 CALCULATION OF THE TWO-POINT FUNCTION OF A STRONG SELF-INTERACTING FIELD IN CONFIGURATION SPACE. Heber, G.; Kuehnel, A.; Slavov, B.; Welzk, S. (Karl-Marx-Univ., Leipzig). Acta Phys. Austr., 25: 73-80(Apr. 1967). (In German).

A previously proposed method to calculate the two-point Green's function of a strongly self-interacting scalar field from its Lagrangian is further developed. Adding and substracting a quadratic term to the Lagrangian the free and the interaction Lagrangian are altered. By this modification one comes to a simpler determination of the poles of the two-point function. Comparing the results obtained in this way with those obtained by analytically continued two-point functions of the previous papers the consistency of the proposed method is shown. (auth)

29402 GENERAL RELATIVISTIC ISOTHERMAL GAS SPHERES. Mehra, A. L. (Univ. of Jodhpur, India). Acta Phys. Austr., 25: 1-4(Apr. 1967).

Solutions of the field equations of general relativity for a gas sphere in gravitational equilibrium under the assumption that the gas obeys an isothermal equation of state are discussed. With suitable transformation the equations of state equilibrium are equivalent to two first order differential equations. These equations are analogous to the Lane-Emden equation in the Newtonian theory. (auth)

29403 RELATIVISTIC STATISTICAL MECHANICS. Hakim, Remi (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Ann. Inst. Henri Poincare, Sect. A, 6: 225-44 (1967). (In French).

After analyzing the reasons why relativistic statistical mechanics cannot be cast into a form similar to the usual one, the relativistic notions of: phase space, Gibbs ensemble, densities, and average values are defined. Next, using the interesting method of Klimontovich, the usual BBGKY hierarchy satisfied by the reduced densities is generalized. Finally, the formalism is applied to the study of some relativistic kinetic equations. Throughout this paper the "action at a distance" formalism is used. (auth)

29404 GRAVITATIONAL CONTRACTION OF CHARGED FLUID SPHERES. Shah, Yashodhara P.; Vaidya, P. C. (Gujarat Univ., Ahmedabad, India). Ann. Inst. Henri Poincare, Sect. A, 6: 219-24(1967).

A model of a charged fluid sphere undergoing gravitational contraction is constructed on the lines of the Oppenheimer–Snyder model of uncharged collapsing spheres. (auth)

29405 STRUCTURE OF THE NONRADIATIVE GRAVITATIONAL FIELD IN GENERAL RELATIVITY. Moret-Bailly, I.; Papapetrou, A. (Institut Henri Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A, 6: 205-18(1967). (In French).

Two theorems concerning nonradiative gravitational fields are derived. They are the analog of two theorems valid for the electromagnetic field in special relativity. The demonstration is given in detail for the axially symmetric gravitational field studied by Bondi. From these theorems the following conclusions will be obtained: the quantity c_0 of Bondi is not sufficient to describe gravitational radiation in detail; bodies in a purely gravitational motion must be the sources of a radiative gravitational field. (auth)

29406 SOME FEATURES OF THE MOTION OF CHARGED PARTICLES IN TIME-VARYING UNIFORM MAGNETIC FIELDS. Glikman, L. G.; Kel'man, V. M.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 37: 370-4 (Feb. 1967). (In Russian).

A discussion is given on the nonrelativistic motion of a charged particle in a uniform magnetic field which is confined to a cylindrical region of circular cross section and is always directed parallel to the axis of that region, but whose magnitude varies arbitrarily with time. It is shown that particles simultaneously leaving a point source in different directions and with different velocities (but all having the same charge to mass ratio) will all simultaneously meet a certain line parallel to the axis of the system at a certain instant, and that particles simultaneously leaving a line source which intersects the axis at right angles, and moving in a plane perpendicular to the axis, will form an aberration-free image of the source at a certain instant. Particles simultaneously leaving an extended source and moving in planes perpendicular to the axis will at a certain instant form an image of the source which, in general, will be distorted; in the case of a static uniform field this image will coincide with the source. An exact solution to the equations is given for the case when the magnetic field strength is inversely proportional to a second degree polynomial in the time. A simple transformation takes the equations for the present problem into those for the motion of a charged particle in an axially symmetric static magnetic field whose strength on the axis varies arbitrarily with distance along the axis; there are therefore analogies between the present results and known laws of the electron optics of static axially symmetric magnetic systems. (ATD)

29407 HYDRODYNAMIC EQUATIONS FOR A NONIDEAL RELATIVISTIC ELECTRON GAS. de Gottal, Ph. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 52: 1318-30(1966).

In an earlier paper (Acad. Roy. Belg. Bull. Classe Sci., 52(5): 1094(1966)), a detailed derivation of the kinetic equation for a spatially inhomogeneous nonideal gas of relativistic electrons was given. This equation was used (Physica., 31: 677(1965)) to deduce the equations of motion of the macroscopic fluid. A detailed account of the results is presented. (W.D.M.)

29408 A NEW OPERATIONAL ARGUMENT IN FAVOR OF THE GENUINE ASYMMETRIC MAXWELL–MINKOWSKI TENSOR. Costa De Beauregard, O. (Paris Univ.). Nuovo Cim. (10), 48B: 293-300(Apr. 11, 1967).

A specific "gedankenexperiment" is defined which, together with the principle of conservation of linear momentum, selects $D \times B$ rather than $E \times H$ or $\frac{1}{2}(E \times H + D \times B)$ as the expression of the electromagnetic momentum density. It is then shown, with reference to a general formula due to Minkowski, that this is tantamount to saying that the genuine asymmetric electromagnetic energy–momentum tensor, as defined by Maxwell and Minkowski, is, rather than the symmetrized one recommended by Hertz and Abraham, the one yielding directly the right expressions for the momentum density and the energy flux. The new consequence of Maxwell's theory considered in this paper might, at first sight, manifest itself as an artifact in Goillot's recent experiments; this point will be discussed in another publication. (auth)

29409 GRAVITATIONAL-RADIATION DETECTION RANGE FOR BINARY STELLAR SYSTEMS. Forward, Robert L.; Berman, David (Hughes Research Labs., Malibu, Calif.). Phys. Rev. Lett., 18: 1071-4(June 12, 1967).

Investigations of the characteristics of the gravitational radiation to be expected from binary systems, and the manner in which this radiation interacts with the present gravitational antenna designs, are summarized. It was found that the behavior of such systems is adequately described by the subrelativistic equations of Peters and Mathews, even for frequencies to 10 kHz and power levels to 10^{48} W, provided the masses are sufficiently dense; in addition it was found that the theoretical maximum power output of a binary system is independent of the total or relative masses of the components. The studies also indicated that the maximum gravitational-radiation detection range for binary systems by mechanically resonant antennas is independent of the type of binary system and for maximum detection range, it is desirable to utilize a wide-bandwidth detector. (W.D.M.)

29410 PHASE METHOD FOR DETERMINING EIGENVALUE FOR THE SCHROEDINGER'S EQUATION. Uvarov, V. B.; Aldonyasov, V. I. Zh. Vychisl. Mat. Mat. Fiz., 7: 436-40(Mar.-Apr. 1967). (In Russian).

A generalized Bohr–Sommerfeld principle was derived and used for determining eigenvalues of the Schroedinger equation $\ddot{y} + xy = q(x)y$. An accurate determination of eigenvalues demanded extensive test calculations. An attempt was made at using more conservative calculation methods based on quasi-classical approximations. The methods were tested with various potentials (Coulomb potential with screening and Thomas–Fermi potential). The energy values are calculated for every iteration with $Z = 57$. (R.V.J.)

29411 MULTIDIMENSIONAL THEORY OF GRAVITATION. Kalitzin, N. St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk, 15: 91-111(1966). (In German).

A multidimensional theory of gravitation that can be indicated as a multitime relativity theory is presented. The multidimensional generalizations of the Einstein vacuum equation $R_{ik} = 0$ are considered. It is assumed that this generalized equation alone describes the gravitational field which appears as multitime. (tr-auth)

29412 MIXTURE OF OUTGOING AND INCOMING ELECTROMAGNETIC RADIATION. CHANGE OF MASS OF THE SOURCE OF RADIATION. Rotenberg, M. A. (Negev Inst. for Arid Zone Research, Beersheva, Israel). Commun. Math. Phys., 5: 23-41 (1967).

In a previous paper the author using a method of successive approximations, verified by means of the Einstein–Maxwell equations of general relativity the well-known result that outgoing electromagnetic radiation from a source conveys energy, so that the source loses gravitational mass corresponding to this energy. The purpose of this work is to show a similar result for the general case of any mixture of outgoing and incoming radiation. (auth)

29413 VVEDENIE V STATISTICHESKUYU RADIOFIZIKU. (Introduction to Statistical Radiophysics). Rytov, S. M. Moscow, Izdatel'stvo Nauka, 1966. 404p.

An introduction is presented to the theory of random functions, based on material from the statistical problems of radiophysics. A few problems were selected to illustrate graphically both the necessity of the introduction of determined mathematical concepts and methods and their utility. (tr-auth)

29414 THE OLD QUANTUM THEORY. (Selected Readings in Physics). ter Haar, D. Oxford, Pergamon Press, 1967. 206p. 21s.

An outline is given of the development of this theory from Planck's first papers on black-body radiation, through the work of Einstein and Rutherford, to the rather complicated theory which was finally replaced by Schrödinger's wave mechanics and Heisenberg's matrix mechanics. It is pointed out that the theory as developed by Bohr, Sommerfeld, Kramers and others gives at least a qualitative explanation of some atomic phenomena. (UK)

29415 MANY-BODY PROBLEMS AND OTHER SELECTED TOPICS IN THEORETICAL PHYSICS. Lectures Delivered at the University of Mexico During the 1965 Session of the Latin American School of Physics. Moshinsky, M.; Brody, T. A.; Jacob, G.

(eds.). New York, Gordon and Breach Science Publishers, 1966. 966p.

Nine lectures are included; separate abstracts are prepared for seven. The two lectures not abstracted for NSA are concerned with symbol-manipulation techniques for physics and critical phenomena. (L.B.S.)

For abstracts of invididual sections see: 29167, 29168, 29352, 29578, 29579, 30053, and 30054.

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 28205.

29416 (TID-4005(Pt.6)) SUMMARIES OF PHYSICAL RESEARCH IN HIGH ENERGY PHYSICS. (Division of Research (AEC), Washington, D. C.). May 1967. 144p. Dep. CFSTI.

Indexes prepared by Division of Technical Information Extension (AEC), Oak Ridge, Tenn.

Summaries are presented of AEC-sponsored research in high-energy physics during FY 1966. Activities include: the construction and operation of accelerators; the development of particle detection and data analysis systems; the conduct of extensive experimental research programs utilizing the accelerators and auxiliary equipment; and the conduct of theoretical research projects. (L.B.S.)

Electromagnetic

29417 (SLAC-PUB-307) ELECTRON COMPTON SCATTERING AT $\Theta = 180°$. Barber, W. C.; Gittelman, B.; Selove, W.; Tompkins, D.; Forman, F. (Stanford Univ., Calif. Pennsylvania Univ., Philadelphia. Dept. of Physics). Feb. 1967. Contract NONR-225(67). 11p. (CONF-670203-4; HEPL-506). Dep. CFSTI.

From International Conference on Electromagnetic Interactions at Low and Intermediate Energies, Dubna, USSR.

The Compton cross section for bremsstrahlung photons of maximum energy 500 and 950 MeV was measured in order to observe attenuation in the backward peak in the differential cross section. It was found that the Klein–Nishina cross section at 180° was verified to within experimental errors. No attenuation of the fermion exchange propagator in electrodynamics which is comparable in magnitude to the effect in strong interactions was found. (J.F.P.)

29418 SEARCH FOR DECAY MODES $\eta \rightarrow \pi^+ + \pi^- + \pi^0 + \gamma$ AND $\eta \rightarrow \pi^+ + \pi^- + \gamma + \gamma$. Price, LeRoy R.; Crawford, Frank S. Jr. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 1207-8 (June 26, 1967).

On the basis of 219 observed eta decays of the type $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ and on zero observed candidates for decays of the type $\eta \rightarrow \pi^+ + \pi^- + \pi^0 + \gamma$ or of the type $\eta \rightarrow \pi^+ + \pi^- + \gamma + \gamma$, experimental upper limits $R \equiv [\Gamma(\pi^+ + \pi^- + \pi^0 + \gamma)/\Gamma(\pi^+ + \pi^- + \pi^0)] < 0.9\%$ and $[\Gamma(\pi^+ + \pi^- + \gamma + \gamma)/\Gamma(\pi^+ + \pi^+ + \pi^0)] < 0.9\%$ are found. The initial sample of four-prong events produced in the hydrogen bubble chamber consists of 4000 events from 1170-MeV/c π^+, 5000 events from 1170-MeV/c π^-, and 2000 events from 1050-MeV/c π^+. The spectra from the $\eta \rightarrow \pi^+ + \pi^- +$ neutrals is shown together with the expected spectra from the studied eta decays. (J.F.P.)

29419 MYSTERY OF THE MUON. Stubbs, Peter. New Sci., 34: 578-9(June 8, 1967).

At CERN, Geneva, a crucial experiment is in progress designed to find out why the muon resembles the electron but is 200 times as heavy. New experiments on the laboratory's sophisticated neutrino beam are also probing similarities between the neutrino and the electron. (auth)

29420 ELECTROMAGNETIC MASS DIFFERENCES OF PSEUDOSCALAR AND VECTOR MESONS IN BOUND-STATE BOOTSTRAP MODELS. Lichard, Peter; Pisut, Jan. Nucl. Phys., B2: 8-20(1967).

Contributions to electromagnetic mass differences of PS- and V-mesons from channels, which might be important in bootstrap are evaluated in a simple potential bound-state model. It is shown that both the SU(6) Fermi-Yang model and the SU(3) Fermi-Yang model with appropriate value of the d/f ratio give results for PS-mesons which are in good qualitative agreement with experiment. The contributions from probably less important channel ($B_8\bar{B}_{10} + \bar{B}_8 B_{10}$) improve the $K^+ - K^0$ but give too small a value of $\pi^+ - \pi^0$ mass differences. On the other hand, models representing PS-mesons as bound states of vector and pseudoscalar or of scalar and pseudoscalar mesons give the wrong sign of the $K^+ - K^0$ mass difference. On this basis it is argued that the baryon–antibaryon channels should dominate meson–meson channels in the bootstrap model of PS-mesons. Electromagnetic mass differences of vector mesons are calculated in both Fermi–Yang and meson–meson models, too, but any comparison with experimental data or any conclusions about their structure cannot be made at present. (auth)

29421 RECENT EXPERIMENTS AT DESY. Jentschke, W. (Deutsches Elektronen-Synchrotron, Hamburg). pp 603-75 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The experimental program at the 6-GeV electron accelerator in Hamburg is mentioned, and the experimental results which were achieved since last fall are described. These experiments include photoproduction, electron scattering, and experiments for testing the validity of QED. (J.F.P.)

29422 INELASTIC SCATTERING OF ELECTRONS BY PROTONS. Cone, A. A.; Chen, K. W.; Dunning, J. R. Jr.; Hartwig, G.; Ramsey, Norman F.; Walker, J. K.; Wilson, Richard (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2752. Phys. Rev., 156: 1490-1507(Apr. 25, 1967). (HUX-2752-21).

The inelastic scattering of electrons by protons was measured at incident electron energies up to 5 BeV/c and momentum transfers $q^2 = 4(\text{BeV/c})^2$. Excitation of known nucleon resonances at M = 1238, 1512, 1688, and possibly 1920 MeV was observed. The calculations for the resonance at M = 1238 MeV were compared with calculations by Adler based on the dispersion theory of Chew, Goldberger, Low, and Nambu. The agreement is good. Qualitative models are discussed for the other resonances. (auth)

29423 PHOTOPRODUCTION CROSS SECTIONS FOR π^+ AND K^+ MESONS AT 3.4 TO 4.0 GeV AND THEIR COMPARISON WITH SU(3). Elings, V. B.; Cohen, K. J.; Garelick, D. A.; Homma, S.; Lewis, R. A.; Lobar, W.; Luckey, P. D.; Osborne, L. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 156: 1433-43(Apr. 25, 1967). (MIT-2098-269).

The differential cross sections for the photoproduction reactions $\gamma + p \rightarrow \pi^+ + n$, $\gamma + p \rightarrow K^+ + \Lambda^0$, and $\gamma + p \rightarrow K^+ + \Sigma^0$ were measured for incident laboratory photon energies between 3.4 and 4.0 GeV and for meson center-of-mass angles from about 25 to 45°. The reactions were studied by observing only the charged mesons. The momenta, velocities, and angles of the mesons were measured with a magnetic spectrometer, and the equivalent of nearly monochromatic gamma rays was obtained by performing bremsstrahlung subtractions. The cross sections agree with the inequality predicted from unbroken SU(3). The measured behavior of $d\sigma/dt$ as a function of t shows similarities to that observed in studies of meson-nucleon scattering. (auth)

29424 PHOTOPRODUCTION OF STRANGE PARTICLES. Phys. Rev., 156: 1426-32(Apr. 25, 1967). (MIT-2098-282).

The photoproduction of strange particles at photon energies between 1 and 6 GeV was studied using a 12-in. hydrogen bubble chamber. 283 events were observed in a sample of 865,000 pictures. Cross sections are presented. $Y_1^*(1382)$ and $K^*(890)$ production were observed in the $\gamma + p \rightarrow \Lambda^0 + K + \pi$ reaction. There is evidence for ϕ^0 production in the $\gamma + p \rightarrow p + K + \bar{K}$ reaction. (auth)

29425 SEARCH FOR $\eta \rightarrow \pi^+ + \pi^- + \pi^0 + \gamma$. Flatte, Stanley M. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 976-7 (May 29, 1967). (UCRL-17514).

The question of whether the mode $\eta \rightarrow \pi^+ + \pi^- + \pi^0 + \gamma$ is comparable to the mode $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ or very much smaller is investigated. The hydrogen bubble chamber was exposed to a beam of mesons (K^-) with momenta between 1.2 and 1.7 GeV/c. Mass plots of the system (η) recoiling against the Λ produced in the interaction studied are shown. It is found that $\Gamma(\eta \rightarrow \pi^+ + \pi^- + \pi^0 + \gamma/\Gamma(\eta \rightarrow \pi^+ + \pi^- + \pi^0) < 0.07$. (J.F.P.)

29426 PHOTOPRODUCTION OF POSITIVE PIONS FROM HYDROGEN BETWEEN 300 AND 750 MeV. Betourne, C.; Bizot, J. C.; Perez-y-Jorba, J.; Treille, D. (Ecole Normale Superieure, Orsay, France). Phys. Lett., 24B: 590-3(May 29, 1967).

The angular distributions for positive pion photoproduction from hydrogen were measured in the energy region 300 to 750 MeV, for pion angles between 50 and 130° in the center of mass system. The pions were analyzed in angle and momentum with a magnetic spectrometer and detected by a counters telescope. (auth)

29427 WIDE ANGLE ELECTRON–ELECTRON SCATTERING ON THE PRINCETON–STANFORD STORAGE RINGS. Barber, W. C. (Stanford Univ., Calif.); Gittelman, B.; O'Neill, G. K.; Richter, B. Contract AT(04-3)-515. pp 266-71 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The angular distribution of elastic electron–electron scattering at an energy of 300 MeV between 40 and 90° in the center of mass was measured with the Princeton–Stanford storage rings. (B.G.D.)

29428 NEUTRAL DECAY MODES OF THE η MESON. Feldman, M.; Frati, W.; Gleeson, R.; Halpern, J.; Nussbaum, M.; Richert, S. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 18: 868-70(May 15, 1967). (NYO-2171-220).

The neutral decay modes of the η are observed by detecting the resulting γ's in a lead-plate spark-chamber array. The η's are produced in the reaction $\pi^- + p \rightarrow n + \eta$, at 707 MeV/c. The neutron is detected with scintillators and its energy measured by a time-of-flight technique. The results for the neutral branching ratios are $2\gamma = (57.9 \pm 5.2)\%$, $\pi^0\gamma\gamma = (24.4 \pm 5.0)\%$, $3\pi^0 = (17.7 \pm 3.5)\%$. (auth)

29429 SOME RECENT MEASUREMENTS OF PROTON FORM FACTORS. Albrecht, W.; Behrend, H.-J.; Dorner, H.; Flauger, W.; Hultschig, H. (Deutches Elektronen-Synchrotron, Hamburg). Phys. Rev. Lett., 18: 1014-15(June 5, 1967).

The results of some further measurements of proton form factors up to very high momentum transfers are presented. Electrons were scattered elastically from a hydrogen target in a 6-GeV electron synchrotron. The electric and magnetic form factors are each shown versus q^2. (J.F.P.)

29430 MEASUREMENTS OF ELASTIC ELECTRON–PROTON SCATTERING AT HIGH MOMENTUM TRANSFER BY A COINCIDENCE TECHNIQUE. Goitein, M. (Harvard Univ., Cambridge, Mass.); Budnitz, R. J.; Carroll, L.; (and others). Phys. Rev. Lett., 18: 1016-18(June 5, 1967).

Measurements of elastic electron-proton scattering cross sections are presented in which both the scattered electron and recoil proton were detected. Cross sections were measured for a range of four-momentum transfers from 10 to 150 F^{-2} with an estimated accuracy of between $3\frac{1}{3}$ and 10%. (auth)

Weak

29431 (UCRL–16455) DECAY PROPERTIES OF THE Ξ HYPERON AND Ξ^* RESONANCES. Merrill, Deane Whitney Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 10, 1966. Contract W-7405-eng-48. 191p. Dep. CFSTI.

Thesis.

A sample of 2500 Ξ^- and 500 Ξ^0 hyperons, produced in ΞK, $\Xi K\pi$, and $\Xi K\pi\pi$ final states by K^- (in H_2) at incident momenta of 1.7 to 2.7 BeV/c was analyzed. The data are from an exposure (K-63) of 26 events/μb in the 72-inch bubble chamber; approximately 85% of the Ξ^- events and 60% of the Ξ^0 events have been analyzed. For the Ξ, we determine the spin and decay parameters α_Ξ and $\Phi_\Xi = \tan^{-1}(\beta_\Xi/\gamma_\Xi)$. Combining our data with 900 Ξ^- and 150 Ξ^0 events from an earlier experiment (K-72), the following results are obtained: Ξ spin: $J = \frac{1}{2}$ favored over $J = \frac{3}{2}$ by ≈ 2.5 standard deviations; Ξ decay parameters (assuming $\alpha_\Lambda = 0.647 \pm 0.048$): $\alpha_{\Xi^-} = -0.398 \pm 0.041$, $\Phi_{\Xi^-} = 9.8° \pm 9.0°$; $\alpha_{\Xi^0} = -0.413 \pm 0.104$. The $\Xi^*(1530)$ and $\Xi^*(1817)$ were observed, the data are insufficient for analysis of suggested Ξ^* resonances at 1705 and 1933 MeV. The $\Xi^*(1530)$ electromagnetic mass difference $\Delta m = m(\Xi^{*-}) - m(\Xi^{*0}) = 2.0 \pm 3.2$ MeV was measured. Using data, part of which was already described, it is found that $\Xi^*(1530)$: $J \geq \frac{3}{2}$ is favored over $J = \frac{1}{2}$ (the $J = \frac{1}{2}$ hypothesis is $\approx 3.5\%$ as probable as the $J = \frac{3}{2}$ hypothesis); $J^P = \frac{3}{2}^+$ is favored over $\frac{3}{2}^-$ by ≈ 2.8 standard deviations. For $\Xi^*(1817)$ decaying into $\Xi^*(1530) + \pi$, the hypotheses $J^P = \frac{1}{2}^+, \frac{1}{2}^-, \frac{3}{2}^-, \frac{5}{2}^+, \frac{7}{2}^-$, etc. (corresponding to $l = 1, 2, 0$ and 2, 1, and 3, and 2 and 4, respectively) are favored over other hypotheses, but results are inconclusive due to large background. (auth)

29432 COMPARISON OF THE K^+ AND K^- DECAY RATES INTO THE τ AND $K_{\mu 2}$ MODES. Ford, W. T.; Lemonick, A.; Nauenberg, U.; Piroue, P. A. (Princeton Univ., N. J.). Phys. Rev. Lett., 18: 1214-18(June 26, 1967).

The K^+ and K^- decay rates into the τ and $K_{\mu 2}$ modes were compared in an experiment at the alternating-gradient synchrotron. The results are $\Gamma(K^+ \rightarrow \pi^+ + \pi^+ + \pi^-)/\Gamma(K^- \rightarrow \pi^- + \pi^- + \pi^+) - 1 = -0.0004 \pm 0.0021$ and $\Gamma(K^+ \rightarrow \mu^+ + \nu_\mu)/\Gamma(K^- \rightarrow \mu^- + \bar{\nu}_\mu) - 1 = -0.0054 \pm 0.0041$. The absolute decay rate for τ was found to be $(4.496 \pm 0.030) \times 10^6$ sec^{-1}. (auth)

29433 RADIATIVE DECAY OF THE MUON. Bogart, E.; DiCapua, E.; Nemethy, P.; Strelzoff, A. (Columbia Univ., New York). Phys. Rev., 156: 1405-14(Apr. 25, 1967).

The radiative decay of the muon, $\mu^+ \rightarrow e^+ + \gamma + \nu_e + \bar{\nu}_\mu$, was measured using muons from the Columbia University Nevis synchrocyclotron. The decay products e^+ and γ were observed at relative angles near 180°, using scintillation counters and two 9-in. × 10-in. NaI crystals, which enabled simultaneous measurement of the positron and γ energies. The pulses from the crystals were displayed on oscilloscopes and photographed, and the measured amplitudes of these pulses were calibrated using the positron spectrum of the nonradiative decay. The two-dimensional energy spectrum for positrons and γ's was obtained for about 900 events, after subtraction of background. This spectrum and the measured rate, obtained by normalizing to the nonradiative decay, were compared with theoretical predictions for the radiative decay. The results were in good agreement with the theory, within statistics, for the case of pure V-A coupling. (auth)

29434 MEASUREMENT OF THE MUON-DECAY SPECTRUM WITH A WIRE SPARK-CHAMBER SPECTROMETER. Sherwood, Bruce Arne (Univ. of Chicago). Phys. Rev., 156: 1475-89 (Apr. 25, 1967).

The momentum spectrum of muon-decay positrons was investigated, in the region above 25 MeV, with a homogeneous magnet containing wire spark chambers with magnetic-core readout. At a given field, this spectrometer accepts, with essentially constant probability and a momentum resolution of ±1%, a 30% momentum range. On the basis of 2.8×10^5 events for the Michel parameter the value $\rho = 0.760 \pm 0.009$ was found (in agreement with V–A) provided the low-energy parameter η was constrained to be zero. Since the two-component neutrino hypothesis ($V + \epsilon A$) predicts $\rho = \frac{3}{4}$ while leaving η free, it is more sensible to impose the constraint $\rho = \frac{3}{4}$ and fit for η; doing this, $\eta = -0.7 \pm 0.6$ was obtained, again in agreement with V–A, which predicts $\eta = 0$. (auth)

29435 NEW DETERMINATION OF THE BRANCHING RATIOS OF K^+-MESON DECAY IN EMULSION. Young, Poh-shien; Osborne, W. Z.; Barkas, Walter H. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 156: 1464-74(Apr. 25, 1967). (UCRL–16973).

A new experiment was carried out to measure the branching ratios for K^+ decay in emulsion under improved conditions. The mesons were brought to rest in a 14-cc volume within a large stack of nuclear-research emulsion. The stack was designed so that the secondaries of the longest range could be followed to rest if they were emitted within certain cones. Some 700 such K^+ decays were chosen as the sample. The principal method for identifying the secondaries was by following the tracks to rest, thus avoiding many sources of systematic error. Ionization measurements were used to resolve ambiguities. The overall scanning efficiency was found to be higher than 95%. The observed branching ratios for the $K_{\mu 2}$, $K_{\mu 3}$, $K_{\tau 2}$, τ, τ', and K_{e3} modes are (61.8 ± 2.9), (5.4 ± 0.9), (19.3 ± 1.6), (6.0 ± 0.4), (2.3 ± 0.6), and (5.3 ± 0.9)%, respectively. These results tend to reconcile the discrepancies between emulsion measurements and heavy-liquid-chamber data. (auth)

29436 K_2^0 INTERACTIONS, DECAYS, AND REGENERATIVE PROPERTIES AT 590 MeV/c IN LIQUID HYDROGEN. Hawkins, C. J. B. (Yale Univ., New Haven). Phys. Rev., 156: 1444-50 (Apr. 25, 1967).

An earlier experiment has reported an "anomalous" coherent regenerative production of K_1^0 mesons in liquid hydrogen. The effect is reinterpreted in terms of a constructive interference between conventional regenerative amplitudes and the CP-violating decay $K_2^0 \rightarrow 2\pi$. Experimental support is given. From new data, the K_2^0 branching ratio $(K_2^0 \rightarrow \pi\mu\nu)/(K_2^0 \rightarrow \pi e\nu)$ was measured to be 0.7 ± 0.2. Results are presented on the decay $K_2^0 \rightarrow \pi^+\pi^-\pi^0$ and on the strong-interaction reactions between K_2^0 mesons and protons at 590 MeV/c. (auth)

29437 COMMENTS ON MEASURING $\mathrm{Re}(A_2/A_0)$ IN THE DECAY $K_S^0 \rightarrow \pi + \pi$. Abbud, F.; Lee, B. W.; Yang, C. N. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 18: 980-2 (May 29, 1967).

An estimate of the electromagnetic correction to the equation $[R_S(+-) - 2R_S(00)/R_S(+-) + R_S(00)] = 2\sqrt{2}\,\mathrm{Re}(A_2/A_0)\cos(\delta_2 - \delta_0)$ is given, and the feasibility of measuring $\mathrm{Re}(A_2/A_0)$ is discussed for the decay $K_S^0 \rightarrow \pi + \pi$. (J.F.P.)

29438 REMEASUREMENT OF THE π^+ LIFETIME. Nordberg, M. E. Jr.; Lobkowicz, F.; Burman, R. L. (Univ. of Rochester, N. Y.). Phys. Lett., 24B: 594-6(May 29, 1967). (UR-875-198).

New data on the $\pi^+ \rightarrow \mu^+ + \nu$ decay lifetime give a value of 26.04 ± 0.05 nsec. A reanalysis of part of the data of a previous experiment which yielded 26.40 ± 0.08 nsec has disclosed previously unseen systematic drifts. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 29866 and 29878.

29439 (INR–775/VI/PH) EMISSION OF FAST DEUTERONS IN VERY LARGE STARS INDUCED BY 9-GeV PROTONS IN NUCLEAR EMULSION. Ciok, Pelagia; Soltan, Marta; Soltynski, Krzysztof (Institute of Nuclear Research, Warsaw (Poland)). 1967. 18p. Dep.

Emission of deuterons of momenta from 520 MeV/c to 720 MeV/c in 102 very large stars ($N_h \geq 28$, N_h-number of heavily ionizing

particles per star) in nuclear emulsion was investigated. The stars belonged to the extreme class of interactions of the 9-GeV protons with heavy nuclei in emulsion (predominantly Ag) corresponding to large energy transfer to the target nucleus. The interactions resulted in the rapid breakup of the nucleus into many nuclear particles. A large abundance of deuterons in the considered momentum interval was observed (1.6 ± 0.3 per star). The results are compared with those obtained previously in the study of other types of interactions and are interpreted in terms of the Butler–Pearson mechanism. (auth)

29440 PRODUCTION OF PIONS, KAONS, AND ANTIPROTONS IN THE CENTER-OF-MASS SYSTEM IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Ratner, L. G. (Argonne National Lab., Ill.); Edwards, K. W.; Akerlof, C. W.; Crabb, D. G.; Day, J. L.; Krisch, A. D.; Lin, M. T. Phys. Rev. Lett., 18: 1218-22(June 26, 1967).

The differential production cross section for the production of various particles in 12.5-GeV/c proton–proton collisions was measured. The experiment was effectively performed in the cms system by making a series of measurements while holding fixed either $P_\parallel$ or $P_\perp$ of the produced particles in the cms system. The production of π^+, π^-, K^+, K^-, and antiprotons varied the center of mass longitudinal momentum between $P_\parallel = 0.0$ and 1.0 GeV/c and $P_\perp^2$ between 0.1 and 1.5 $(GeV/c)^2$. Plots of the production cross sections for the studied particles versus momentum are given. (J.F.P.)

29441 STRUCTURES IN THE $\bar{p}p$ AND $\bar{p}d$ TOTAL CROSS SECTIONS BETWEEN 1.0 AND 3.3 GeV/c. Abrams, R. J.; Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Leontic, B. A.; Li, K. K.; Michael, D. N. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 1209-12(June 26, 1967). (BNL–11356).

Three structures are observed in $\bar{p}$-p and $\bar{p}$-d total cross sections in a transmission experiment. Two structures, at center-of-mass energies 2190 ± 5 and 2345 ± 10 MeV respectively, are found in the isospin-one state. The third structure, at 2380 ± 10 MeV, is found in the isospin-zero state. (auth)

29442 ANALYSIS OF PROTON–NUCLEON INTERACTIONS IN NUCLEAR EMULSIONS AT INCIDENT MOMENTA 24 AND 27 GeV/c. Kamal, A. A.; Rao, G. K. (Osmania Univ., Hyderabad, India). Nucl. Phys., B2: 135-56(1967).

Analysis of proton-nucleon interactions in nuclear emulsions, at incident momenta 24 and 27 GeV/c is presented. Application of suitable selection criteria, to events with $N_H = 0$ to 4, is shown to ensure that the sample is consistent with proton-nucleon interactions. The "solo shower stars" are interpreted as quasi-elastic events. Momentum distributions for identified pions and protons are presented in the center-of-mass system. The transverse momentum distributions are compared with the statistical theory. The production frequency of π^0 mesons in small and large multiplicity groups is deduced. The ratio charge/neutral for pions is shown to vary with N_S. The inelasticity distributions deduced from the angular measurements, are shown to be continuous. It is concluded that the effective target mass does not necessarily compel one to associate with the target the mass of a real pion. (auth)

29443 PRODUCTION FREQUENCY OF HYPERFRAGMENTS IN 5 GeV/c ANTIPROTON INTERACTIONS. Shanthalakshmi, A.; Indira, B.; Kamal, A. A. (Osmania Univ., Hyderabad, India). Can. J. Phys., 45: 2221-3(June 1967).

In a stack of G-5 emulsion consisting of 41 pellicles exposed to a $\bar{p}$ beam of momentum 5 GeV/c, 10,168 beam stars were found by area scanning. It is concluded that two or three of the hyperfragments result from a direct production of Λ^0 and the remaining are attributed to an indirect process. (F.S.A.)

29444 SPIN CORRELATION PARAMETER A_{xx} AND A_{yy} MEASUREMENTS IN p-p SCATTERING FROM 11 MeV TO 26 MeV. Catillon, P.; Chapellier, M.; Garreta, D. (CEN, Saclay, Gif-sur-Yvette, France). Nucl. Phys., B2: 93-109(1967).

The A_{xx} and A_{yy} spin correlation coefficients of proton–proton scattering were measured with an accuracy better than 2% at lab energies of 11.4, 19.15, 23.45 and 26.5 MeV for the center-of-mass scattering angle of 90°. The measurements were made by scattering a polarized proton beam on a polarized proton target. (auth)

29445 MEASUREMENT BY PROTON-1 OF EFFECTIVE CROSS SECTIONS OF INTERACTIONS BETWEEN INELASTIC PROTONS AND CARBON NUCLEI WITH ENERGIES OF 10^{10} TO 10^{12}eV. Basilova, R. N.; Grigorov, N. L.; Kakhidze, G. P.; Kovrizhnykh, O. M.; Savenko, I. A.; Nesterov, V. E.; Rapoport, I. D.; Skuridin, G. A.; Titenkov, A. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1610-13(Oct. 1966). (In Russian).

An ionization calorimeter of the SEZ-14 type was carried on board the Proton-1 satellite to measure the effective cross sections of inelastic interactions between protons and carbon nuclei with energies up to 10^{12} eV. Correct measurement of the effective cross sections requires that the primary particles be selected with respect to their interaction in the calorimeter in such a way that conditions under which energy release occurs will not be affected when targets are placed in the paths of the particles. To accomplish this, events in which the particles pass through the targets without interaction are recorded. One carbon and one polyethylene target were used in the SEZ-14 calorimeter, which was designed in the form of two identical halves. The targets were shifted from one half into the other and were taken out of the calorimeter twice during each 24-hour measurement period. The intensity of proton fluxes (energy E) which passed without interaction through the carbon (N_c (E)) and polyethylene (N_{CH_2} (E)) targets in the absence of an N_0(E)) target, was measured independently in each half of the calorimeter. The results obtained are shown. (ATD)

29446 p–d ELASTIC SCATTERING AT LARGE ANGLES IN THE ENERGY REGION 1 TO 3.5 GeV. Bajukov, Y. D.; Birguer, N. G.; Bisheva, G. K.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Lett., 24B: 598-600 (May 29, 1967).

Differential cross sections of p-d elastic scattering at large angles ($\theta_{cm} \geq 150°$) were measured in the energy interval 1 to 3.5 GeV. The results are compared with pole model predictions. (auth)

29447 ANNIHILATIONS OF ANTIPROTONS AT REST IN HYDROGEN. VI. KAONIC FINAL STATES. Barash, N.; Kirsch, L.; Miller, D.; Tan, T. H. (Columbia Univ., New York). Phys. Rev., 156: 1399-1405(Apr. 25, 1967).

Experimental results are presented on the annihilation of stopped antiprotons into $K\bar{K} + 3\pi$, $K\bar{K}\eta$, and $K\bar{K}\omega$. The branching ratios for $\bar{p} + p \rightarrow K_1K_1\eta$ and $\bar{p} + p \rightarrow K_1K_1\omega$ were found to be $(0.25 \pm 0.04) \times 10^{-3}$ and $(1.08 \pm 0.16) \times 10^{-3}$, respectively. From events of the latter reaction the width of the ω meson was found to be 12.3 ± 2.0 MeV. The E^0 meson was observed and evidence was seen for the assignment of even charge conjugation and even G parity to this resonance. In addition, events from the reaction $\bar{p} + p \rightarrow K_1K^+\pi^+$ were used to measure the mass difference between the charged and neutral K^*. $M_{K^{*0}\bar{K}^{*0}} - M_{K^{*\pm}} = 6.3 \pm 4.1$ MeV was obtained. (auth)

29448 TIME-LIKE FORM FACTOR OF THE NUCLEON AND ITS CONSEQUENCES ON THE EXPERIMENTS WITH COLLIDING ELECTRON–POSITRON BEAMS. Conversi, M.; Massam, T.; Muller, Th.; Zichichi, A. (CERN, Geneva). pp 289-95 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

An experiment on proton-antiproton annihilation into lepton pairs are reported and its consequences with respect to colliding beam experiments are discussed. (B.G.D.)

29449 SEARCH FOR FRACTIONALLY CHARGED PARTICLES IN COSMIC RAYS NEAR SEA LEVEL. Gomez, R.; Kobrak, H.; Moline, A.; Mullins, J.; Orth, C.; Van Putten, J.; Zweig, G. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 18: 1022-4(June 5, 1967). (CALT–68-120).

An array of spark chambers and scintillation-counter trays was used to search for fractionally charged particles in cosmic rays near sea level. No acceptable events were found with energy losses by ionization between 0.04 and 0.7 that of singly charged minimum-ionizing particles. This experiment sets new upper limits for the fluxes of fractionally charged particles in cosmic rays, namely, 1.7×10^{-10} and 3.4×10^{-10} cm^{-2} sr^{-1} sec^{-1} (90% confidence) for minimum-ionizing particles with charges $\frac{1}{3}$ and $\frac{2}{3}$, respectively. (auth)

29450 TWO-PROTON FINAL-STATE INTERACTIONS IN THE REACTIONS D(^{3}He,t)2p AND ^{3}He(d,t)2p AT A CENTER-OF-MASS ENERGY OF 21 MeV. Morton, B. J.; Gross, E. E.; Malanify, J. J.; Zucker, A. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 18: 1007-9(June 5, 1967). (ORNL–P–3000).

Triton spectra were measured at 0 and 3° for the reaction D(^{3}He,t)2p and at 5° for the reaction ^{3}He(d,t)2p at the same c.m. energy (21 MeV). The results were compared with predictions of the Watson–Migdal final-state interaction theory, and the proton-proton scattering length a_p was determined for each reaction. Although the overall fit for the first reaction is poor, the best fit to the high-energy region of the data is obtained for $a_p = -12.6 \pm 0.6$ F. For the second reaction, $a_p = -7.3 \pm 0.6$ F gives a reasonably good overall fit. (auth)

Strong (Meson-Induced)

Refer also to abstract 29436.

29451 (CEA-R-3035) PRODUCTION DE L'ISOBARE N_{33}^{*++} ET INTERACTION $\pi\pi$ DANS L'ETAT D'ISOSPIN I = 2, ETUDIEES DANS LA REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ A 2.75 GeV/c. (Production of the Isobar N_{33}^{*++} and the $\pi\pi$ Interaction in the Isospin 2 State, Studied in the Reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 2.75 GeV/c). Alitti, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 81p. (In French). Dep. Thesis. Submitted to Paris Univ., Orsay, France.

A study of the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 2.75 GeV/c was carried out in an 81 cm liquid hydrogen bubble chamber at the proton synchroton. One observes that the abundant N_{33}^{*++} (1236 MeV) isobar production occurs predominantly backwards in the center of mass of the reaction. This feature suggests a peripheral production mechanism with π exchange. The validity of this hypothesis, which allows one to study the $\pi^-\pi^-$ interaction within the frame of the Chew and low model is verified. Among other results one finds for the isospin-2 state the values of the elastic $\pi\pi$ cross section and of the S and D wave phase shifts. (auth)

29452 (TID-23823) THE REACTION $K^+p \rightarrow K^0\pi^+p$ AT 2.26 GeV/c. Bomse, Frederick; Borenstein, Samuel; Cole, James; Gillespie, Daniel; Luste, George; Moses, Edward; Pevsner, Aihud; Zdanis, Richard (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). [1965]. 32p. Dep. CFSTI.

The properties of the K*(895 MeV) and N* (1238 MeV) resonances produced in the reaction $K^+p \rightarrow K^0\pi^+p$ at 2.26 GeV/c are studied. The production of one or the other of these resonances is found to occur in this channel 80% of the time. The decay correlations of the K* and N* indicate that the dominant mechanism involved in their production may be single vector meson exchange. In particular the decay angular distributions of the N* are in good agreement with the predictions of the Stodolsky-Sakurai model. The experimental differential cross sections for production of each of these resonances are also compared with theoretical predictions based on a single meson exchange model which includes the effects of absorption due to competing channels. The agreement of the data with the theory is found to be only moderate. (auth)

29453 (UCRL-11697) A MEASUREMENT OF THE DIFFERENTIAL CROSS SECTIONS FOR CHARGE EXCHANGE AND RADIATIVE CAPTURE OF NEGATIVE PIONS IN HYDROGEN AT 50 MeV LABORATORY ENERGY. Carroll, Jim B. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1967. Contract W-7405-eng-48. 62p. Dep. CFSTI. Thesis.

The differential cross sections of $\pi^- + p \rightarrow \gamma + n$ and $\pi^- + p \rightarrow \pi^0 + n$ ($\rightarrow \gamma + \gamma + n$) were measured at an incident pion laboratory-system kinetic energy of 54 MeV. The reactions were identified by detecting and measuring the energy of a final-state photon with a large total absorption counter placed at a laboratory-system angle of 84 deg. Analysis of the photon energy spectrum yields the center-of-mass differential cross section for the first reaction, $d\sigma_1/d\Omega^*$ ($\theta^* = 90$ deg) = 51.5 ± 10.7 μb/sr, and the coefficients of the Legendre expansion of the center-of-mass system differential cross section for the second reaction, $d\sigma_2(\theta^*)/d\Omega^* = \Sigma_{l=0}^{2} A_l P_l$ (cos θ^*), where $A_0 = 0.68 \pm 0.04$ mb/sr, $A_2 = 0.53 \pm 0.09$ mb/sr, and A_1 is not determined. Using the principle of detailed balance, and the measurement of the cross section for the first reaction, the isotropic term in the cross section for the reaction $\gamma + n \rightarrow \pi^- + p$ were calculated, and the results obtaining $a_0^- = 15.4 \pm 3.2$ μb/sr at $p_\gamma^* = 170$ MeV/c were obtained. This value is in reasonable agreement with other data obtained from photoproduction in deuterium. (auth)

29454 PRODUCTION OF K$\pi\pi$ RESONANCES AT HIGH ENERGY. Berlinghieri, J.; Farber, M. S.; Ferbel, T.; Forman, B.; Melissinos, A. C.; Yamanouchi, T.; Yuta, H. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev. Lett., 18: 1087-91 (June 12, 1967). (UR-875-195).

The previously observed enhancement between 1100 and 1400 MeV in the K$\pi\pi$ mass spectrum is interpreted as a T = ½, $J^P = 1^+$ resonance at 1280 ± 20 MeV and width of 130 ± 15 MeV which decays into π + K* and into K + ρ. Evidence is also presented supporting the existence of the newly reported L meson. (auth)

29455 CONTRIBUTION OF VECTOR MESON EXCHANGE TO ρ^- PRODUCTION AT 4.2 GeV/c. Yen, W. L.; Eisner, R. L.; Gutay, L.; Johnson, P. B.; Klein, P. R.; Peters, R. E.; Sahni, R. J.; Tautfest, G. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 18: 1091-4(June 12, 1967).

Two-prong $\pi^- + p \rightarrow p + \pi^- + \pi^0$ interactions were obtained from an exposure of a hydrogen bubble chamber to an incident beam of 4.2-GeV/c mesons (π^-). There were 2900 such events identified. The results of an analysis of the interaction $\pi^- + p \rightarrow \rho^- + p$ are presented. The di-pion effective-mass distribution is studied for different intervals of the negative invariant four-momentum transfer squared from the incident to the outgoing proton. (J.F.P.)

29456 INELASTIC PROCESSES NEAR THE T = 1 K^+p PEAK AT 1250 MeV/c. Bland, R. W.; Bowler, M. G.; Brown, J. L.; Goldhaber, G.; Goldhaber, S.; Seeger, V. H.; Trilling, G. H. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev. Lett., 18: 1077-80(June 12, 1967). (UCRL-17432).

K^+p inelastic final states in the region of the 1250-MeV/c Cool peak are examined for evidence of resonant behavior. The dominant KN* final state is found to be about equally divided between $P_{\frac{1}{3}}$ and $P_{\frac{3}{3}}$ final states, with no rapid phase variation between 960 and 1370 MeV/c. (auth)

29457 K^-p ELASTIC SCATTERING AT 2.24 GeV/c. Dickinson, M. (Univ. of Colorado, Boulder); Miyashita, S.; Libby, L. Marshall; Kearney, P. Contract AT(11-1)-1537. Phys. Lett., 24B: 596-8(May 29, 1967).

The differential elastic scattering cross section for 2.24 GeV/c K^-p collisions was measured in film from the Brookhaven 20" bubble chamber. The total elastic cross section is found to be 6.2 ± 0.7 mb. The exponential dependence on square of the momentum t in $(GeV/c)^2$ is fitted by $(d\sigma/d\Omega)$ elastic = (12.4 ± 1.0 mb/sr) exp (7.81 ± 0.25) t. A fit to a black disc model requires a radius of 0.95 ± 0.05 fm. (auth)

29458 PION-PROTON CHARGE-EXCHANGE SCATTERING FROM 500 TO 1300 MeV. Chiu, Charles B. (Univ. of California, Berkeley); Eandi, Richard D.; Helmholz, A. Carl; (and others). Phys. Rev., 156: 1415-26(Apr. 25, 1967). (UCRL-17209(Rev.)).

Differential cross sections for the reaction $\pi^-p \rightarrow \pi^0n$ were measured at nine incident-pion kinetic energies in the interval from 500 to 1300 MeV. The negative pion beam from the bevatron was focused on a liquid-hydrogen target completely surrounded by a cubic array of six steel-plate spark chambers. The spark chambers were triggered on events with neutral final states. Charge-exchange events were identified from the one-shower and two-shower events in the spark-chamber pictures. By the Monte Carlo technique, the π^0 distributions were calculated from the bisector distributions of the two-shower π^0 events together with the observed γ-ray distributions of the one-shower π^0 events. These π^0 distributions were fitted with both Legendre-polynomial expansions and power-series expansions by the method of least squares. The extrapolated forward differential cross sections are in good agreement with the dispersion calculations. The Legendre coefficients for the differential cross sections in isospin state T = ½ were obtained by combining our results with available data on π^+p elastic scattering. In the light of existing phase-shift solutions, the behavior of these coefficients is discussed. The D_3F_3 interference term that peaks near 900 MeV is verified to be in isospin state T = ½ only. The total neutral cross sections and the cross sections for the production of neutral multipion final states $2\pi^0n$ and $3\pi^0n$ are also reported. The 4π solid angle and the calibrated energy response of the spark chambers contribute to the accuracy of the results. (auth)

29459 INVESTIGATION OF s-WAVE $\pi\pi$ INTERACTION FROM THE REACTION $\pi^-p \rightarrow \pi^0\pi^0n$. Corbett, I. F. (Nuclear Physics Lab., Oxford); Damerell, C. J. S.; Middlemas, N.; Newton, D.; Clegg, A. B.; Williams, W. S. C.; Carroll, A. S. Phys. Rev., 156: 1451-64(Apr. 25, 1967).

Measurements of the reaction $\pi^-p \rightarrow \pi^0\pi^0n$ at incident momenta of 1.715, 1.889, 2.071, 2.265, and 2.460 GeV/c are presented. They show two important contributions to this reaction: (i) production of the 1238-MeV isobar and a recoil pion, and (ii) peripheral production of the dipion system. The consequences of assuming the latter to be due to the reaction $\pi^-\pi^+ \rightarrow \pi^0\pi^0$ are explored. This reaction has the advantage that it cannot take place in an I = 1, l = 1 state and so should be useful for a study of the s-wave $\pi\pi$ interaction. The measured $\pi\pi$ mass spectrum from peripheral production shows no evidence for any of the relatively narrow s-wave resonances which have been proposed, but shows a broad peak centered at about 600 and about 400 MeV wide. Some evidence that this peak may be a broad s-wave resonance is deduced from a comparison with information about the s-wave interaction deduced from the $\pi^-\pi^+$ asymmetry in the reaction $\pi^-p \rightarrow \pi^-\pi^+n$; conclusions are reached which agree with a number of other experimental results. Against this resonance interpretation it is found that a calculation of the peripheral production cross section expected for such a resonance, made by assuming the one-pion-exchange formula with the Ferrari-Selleri form-factor modification, is approximately three times greater than our measured cross section. This may mean that the modification of the one-pion-exchange formula is larger for s-wave $\pi\pi$ interaction than it is for p and d waves. (auth)

29460 PHYSICS WITH PHOTON AND ELECTRON BEAMS: REQUIREMENTS OF EXPERIMENTERS IN TERMS OF ENERGY, INTENSITY, AND QUALITY. Salvini, G. (Univ., Rome). pp

197-210 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The photoproduction of strong particles, the physics of form factors, and the verification of electrodynamics are discussed. (B.G.D.)

29461 USE OF COSMIC RAYS TO STUDY PHYSICS IN THE RANGE 100 TO 1000 GeV. Jones, L. W. (Univ. of Michigan, Ann Arbor, CERN, Geneva). pp 66-70 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A mountain top cosmic ray experimental facility employing spark chambers, large magnets, and a liquid hydrogen target is described. (B.G.D.)

29462 STUDY OF THE $\pi\rho$ SYSTEM IN THE REACTION $\pi^- + p \rightarrow \pi^- + \rho^0 + p$ AT 8 GeV/c. Cason, N. M.; Lamsa, J. W.; Biswas, N. N.; Derado, I.; Groves, T. H.; Kenney, V. P.; Poirier, J. A.; Shepard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev. Lett., 880-2(May 15, 1967).

In the reaction $\pi^- + p \rightarrow \pi^- + \rho^0 + p$ at 8 GeV/c, it is found that the A_1 can be explained as a kinematic effect due to a Deck-type mechanism, but only if both π and ρ exchanges are included. Also evidence for a possible $\pi^-\rho^0$ resonance at 1190 MeV with a width of 17 MeV is presented. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 29416.

29463 (AED-C-23-12) HIGH ENERGY PHYSICS INDEX, Volume 5, Number 4(1269-1956). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 244p. Dep.

The high energy physics index contains experimental physics including general reactions, weak, electromagnetic, and strong interactions, strange particles, accelerators, methods and instruments, and general experiments. Theoretical physics is also covered including general, weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory. Author, report number, and subject indexes are given. (J.F.P.)

29464 (ITF-67-3) ON SUMMATION OF CONTRIBUTIONS FROM THE FEYNMAN DIAGRAMS, AN EXISTENCE THEOREM. I. Petrina, D. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 39p. Dep.

An attempt is made to sum up the contributions from the Feynman diagrams for the model of a neutral scalar field with the interaction Lagrangian $g\phi^3(x)$. (J.F.P.)

29465 SPIN-FAMILY SOLUTION OF A FUNDAMENTAL EQUATION. Van Der Spuy, E. (Atomic Energy Board, Pelindaba, South Africa). Nucl. Phys., B2: 21-32(1967).

The idea is introduced that a suitably general field theoretical equation of motion may possibly have at least two quite different types of solutions. One is a basically perturbative solution which if at all possible is conjectured to correspond to a renormalized solution with weak interaction. The other solution which is basically nonperturbative is conjectured to correspond to a strongly interacting family, or families. The former solution uses the interpretation of the field operators current in quantum field theory, but the latter extends the meaning of the field operators, in the spirit of the correspondence principle, in that they generate only spin families. The notion of spin family is formally related to that in the Regge theory. Firstly the Lorentz and C, T, P invariance of the equation and its continuation in j is discussed. Then the equation leads to a relation between the propagator and the vertex function. The invariant representation of the propagator and the vertex function of three general spins is then discussed. (auth)

29466 CURRENT ALGEBRA. Gell-Mann, M. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. pp 173-201 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

A review of the main ideas of current algebra is given, and the frame $P = \infty$ is considered. The experimental tests of the assumptions are discussed. Extension of the chiral SU(3) ⊗ SU(3) algebra, and investigations of the possibility of finding an infinite dimensional representation of the complete set of commutators for the local U(3) ⊗ U(3) algebra are considered. (J.F.P.)

29467 COMMUTATORS OF CURRENT COMPONENTS. Gatto, R. (Univ., Florence). pp 565-77 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

Some general aspects of relevant commutation relations are considered in the discussion of commutators of current components. The problem of the validity of the commutation rules of the naive quark model is covered, and a field theoretic argument is given. (J.F.P.)

29468 VECTOR MESON DOMINANCE AND CURRENT ALGEBRA. Sakurai, J. J. (Chicago, Univ., Ill.). pp 48-61 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The connection between current algebra and vector meson dominance is explored and clarified, with applications to elastic soft-pion scattering, the radiative decays of heavy mesons and the parity-nonconserving nonleptonic decays of K mesons and hyperons. (L.B.S.)

29469 SOURCERY. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). pp 180 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

A brief description is given of a new kind of particle theory based on the source concept, which is intermediate in concept between the extremes of S-matrix and field theory. Through the use of sources the production and detection of particles, as well as their interaction is incorporated into the theoretical description. (L.B.S.)

29470 SYMMETRY AND ELEMENTARY PARTICLE PHYSICS. Cabibbo, N. (Univ., Rome. CERN, Geneva). pp 181-9 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

A summary is given of the works presented at the Fourth Coral Gables Conference on recent advances in knowledge of elementary particle physics obtained through the use of symmetry principles. The topics discussed include: the origin of higher symmetry; algebra of currents; saturation of local commutation relations; problems of relativistic noncompact dynamic groups; high-energy behavior of scattering amplitudes; and the physical approach to the dynamics of high-energy particles. (L.B.S.)

29471 ALGEBRA OF FIELDS. Lee, T. D. (Columbia Univ., New York); Weinberg, Steven; Zumino, Bruno. Phys. Rev. Lett., 18: 1029-32(June 5, 1967).

It is shown that the algebra of gauge fields can be used to rederive all results that can be derived from current algebra and that it also makes definite statements about these other commutators. This additional information is then used to compute and generalize the proof of the spectral-function sum rules, and an argument is given in support of the view that the hadronic electromagnetic current is to be identified with an appropriate combination of gauge fields. (J.F.P.)

29472 RECENT DEVELOPMENTS IN PARTICLE PHYSICS. Proceedings of the First Pacific International Summer School in Physics, August 1965, Honolulu, Hawaii. Moravcsik, Michael J. (ed.). A Series of Monographs and Texts in High-Energy and Low-Energy Nuclear Physics. Volume 2. New York, Gordon and Breach Science Publishers, 1966. 263p. $15.00.

The conference included 6 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 29473, 29474, 29514, 29515, 29590, and 29591.

29473 PARTICLES AND CROSS SECTIONS IN A THEORY OF LOCAL OBSERVABLES. Haag, Rudolf (Univ. of Illinois, Urbana). pp 1-21 of Recent Developments in Particle Physics. Moravcsik, Michael J. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The discussion of particles and cross sections in theory of local observables includes the basic assumptions and framework for particle theory versus field theory, localized states, multiple localization, and asymptotic particle number, the construction of scattering states, generalized LSZ relations, and spontaneous breakdown of symmetries and the Goldstone theorem. (J.F.P.)

29474 NON-DYNAMICAL STRUCTURE OF PARTICLE REACTIONS. Moravcsik, Michael J. (Univ. of California, Livermore). pp 197-263 of Recent Developments in Particle Physics. Moravcsik, Michael J. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Some features of particle reactions which are independent of any assumptions about the forces acting between these particles

are discussed. The consequences of all general conservation laws are explored. The topics covered are the number of form factors and observables, factorization of the M-matrix and of the observables, parity experiments, formalism for calculation of observables, and the structure of observables. (J.F.P.)

Electromagnetic

29475 POSSIBLE C VIOLATION IN ELECTROMAGNETIC PROCESSES. Jacob, M. (CEN, Saclay, France). Acta Phys. Acad. Sci. Hung., 22: 79-97(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The various ways in which C noninvariance could appear in electromagnetic interactions are reviewed and the pertinent experimental consequences are analyzed with a detailed discussion of a few typical cases. It is stressed that, even though C invariance might be badly broken, all experiments one can think of, at present, in order to observe its possible consequences, appear as searches for a measurable effect of at most a few per cent. This is due to various reasons which are indicated. (auth)

29476 REMARK ON THE $\pi^0 \rightarrow 3\gamma$ DECAY. Galfi, L.; Marx, G. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 22: 99-101(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

A theoretical upper limit on the rate of the C violating decay is given. (auth)

29477 STATIC QUARK MODEL. Pietschmann, H. (Inst. of Theoretical Physics, Goteborg. Inst. for Theoretical Physics, Vienna). Acta Phys. Acad. Sci. Hung., 22: 165-73(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The radiative decay widths for pseudoscalar and vector mesons are calculated in the static quark model. (auth)

29478 ELECTROMAGNETIC MASS DIFFERENCES AND CURRENT ALGEBRAS. Suranyi, P. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 22: 301-6 (1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

A sum rule for the electromagnetic mass difference of elementary particles is derived using the methods of current algebras. An expression for the proton-neutron mass difference is given in terms of the proton-electron and neutron-electron cross sections. (auth)

29479 S-MATRIX EVALUATION OF ELASTIC ELECTRON–PROTON SCATTERING. Lu, T. H. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 5: No. 1-2, 9-22(Dec. 1966).

The general treatment of the electron–proton scattering is given by the form factor calculation. But certain assumptions are made and it is calculated through S-matrix treatment. Also results are compared with the experimental data. Qualitative explanation for deviated results is tentatively presented. (auth)

29480 ELECTROMAGNETIC MASS SPLITTINGS OF MESONS AND BARYONS IN THE QUARK MODEL. Gal, Abraham (Weizmann Inst. of Science, Rehovoth, Israel); Scheck, Florian. Nucl. Phys., B2: 110-20(1967).

Relations for the electromagnetic mass differences of mesons and baryons which can be derived from the quark model under various assumptions are critically reviewed and discussed in some detail. In particular, in the case of mesons, the mass-dependent corrections arising from the spatial structure of mesons and which were found necessary in the description of weak and electromagnetic decays in the quark model are examined and are found to be consistent with experimental data. It is found however that more accurate data on the K* and the ρ mass differences are needed to decide whether the spatial structure of all pseudoscalar and vector mesons is the same or whether it depends sensitively on the meson mass. (auth)

29481 SOME TOPICS OF RECENT INTEREST IN π AND η PHOTOPRODUCTION. Heusch, C. A. (California Inst. of Tech., Pasadena). pp 578-602 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

Photoproduction processes in the energy region below 2 GeV are considered, and some recent experiments on the photoproduction of neutral pseudoscalar mesons are reviewed. (J.F.P.)

29482 MESON PHOTOPRODUCTION NEAR THRESHOLD AND CURRENT COMMUTATION ALGEBRA. Konuma, M. (Univ., Louvain, Belg.). pp 676-83 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The algebra of current commutation relations and the hypothesis of PCAC are applied for the treatment of the photoproduction of mesons near threshold $\gamma + N \rightarrow B_i + M$, ($i$ = 8, 10), where N, M, B_8, and B_{10} are nucleon, pseudoscalar meson octet (0^-), baryon octet ($\frac{1}{2}^+$), and decuplet ($\frac{3}{2}^+$), respectively. Related experimental results are summarized. (J.F.P.)

29483 QUARK MODEL FOR PHOTOPRODUCTION OF BARYONS. Das Gupta, Sutapa; Mitra, A. N. (Univ. of Delhi). Phys. Rev., 156: 1581-4(Apr. 25, 1967).

A quark (Q) model of photoproduction of positive- and negative-parity baryons in association with a meson octet is proposed. According to this model, the basic mechanism for photoproduction is represented by a U-spin-invariant process $\gamma + Q \rightarrow Q + \Pi$ at each quark, Π being a meson octet. The matrix elements of this basic amplitude are taken between appropriate 3Q states representing the initial proton and a final baryon, according to the multiplet structure 56^+ of SU(6) and $(70,3)^-$ of SU(6) $\otimes$ O(3) for the positive-parity and negative-parity baryonic states, respectively. The SU(3) sum rules based on U-spin invariance of the amplitudes are verified. Several additional sum rules, valid separately for spin-flip and non-spin-flip amplitudes, are derived for the 56^+ states. For the negative-parity states, a number of nontrivial sum rules connecting different SU(3) multiplets are obtained. (auth)

29484 STRUCTURE OF THE $\eta \rightarrow 3\pi$ AMPLITUDE. Woo, Ching-hung (Univ. of Maryland, College Park). Phys. Rev., 156: 1719-23(Apr. 25, 1967).

Difficulties with the usual phenomenological theory of the C-conserving part of $\eta \rightarrow 3\pi$, with $|\Delta I| = 1$ and dominance by the nearly constant symmetric amplitude, are summarized. It is discussed why the difficulties are indicative of the presence of a significant asymmetric part in the amplitude. An attempt is made to find the possible reductions in the theoretical branching ratio $R = \Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)$ as a result of including some large asymmetric parts. It is found that a branching ratio of the order $R \approx 1.1$ is the lower limit of what can be reasonably achieved in these theories. If the experimental value should turn out to be $R \simeq 0.5$, it will be extremely difficult to reconcile with the theory even when large energy variations in the decay amplitude are allowed for; and it is nearly certain that a part with $|\Delta I| > 2$ is present in $\eta \rightarrow 3\pi$ in that case. (auth)

29485 CURRENT ALGEBRA AND $\eta \rightarrow 3\pi$ DECAYS. Das, T.; Grynberg, M.; Kikkawa, K. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 156: 1568-72(Apr. 25, 1967). (UR-875-173).

By making use of the algebra of currents and the notion of a "generalized partially conserved axial-vector current" the rates for the $\eta \rightarrow 3\pi$ decays as well as the energy spectrum of the $\eta \rightarrow \pi^+\pi^-\pi^0$ mode were calculated. The calculated width of $\eta \rightarrow 3\pi^0$ is ~120 eV which is compatible with the value obtained by using SU(3) to obtain the rate for $\eta \rightarrow 2\gamma$ from the known rate of $\pi^0 \rightarrow 2\gamma$ and then using the experimental branching ratios of $\eta \rightarrow 2\gamma$ and $\eta \rightarrow 3\pi^0$. However, the slope of the matrix element for $\eta \rightarrow \pi^+\pi^-\pi^0$ with respect to the kinetic energy of the π^0 is found to be $\alpha \sim -0.48$, in contrast with the experimental value of $\alpha \sim -0.87$. It is indicated how a ρ-pole-dominance model can also give at least the correct sign of the slope. It is also emphasized that even if one uses the experimental value of α and restricts oneself to the usual electromagnetic interactions ($\Delta I = 1$) the ratio $\Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)$ turns out to be ~1.4, in contrast with the experimental value of 0.83 ± 0.13. (auth)

29486 TOTAL ANNIHILATION CROSS SECTION OF ELECTRON–POSITRON PAIRS INTO HADRONS AT HIGH ENERGIES. Gribov, V. N.; Ioffe, B. L.; Pomeranchuk, I. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 24B: 554-7(May 29, 1967).

The asymptotic behavior of the total cross section of the $e^+ + e^- \rightarrow$ hadrons process at high energies is investigated. It is shown that at high E, $\sigma \sim \text{const.}/E^2$, where E are the energies of e^+ and e^- in the cms. (auth)

29487 LOWER BOUND ON THE DECAY RATE FOR $\eta \rightarrow \mu^+ + \mu^-$. Callan, Curtis G. Jr.; Treiman, S. B. (Princeton Univ., N. J.). Phys. Rev. Lett., 18: 1083-4(June 12, 1967).

One of the minor decay modes $\eta \rightarrow \mu^+ + \mu^-$ is considered. Because of favorable circumstances peculiar to the meson (η), one can reliably set a lower bound on the rate for the rare process considered (relative to the dominant mode $\eta \rightarrow 2\gamma$). One supposes that parity conservation holds for the strong and electromagnetic interactions. Then from CPT invariance assumed valid one derives a unitary relation for the imaginary part of the $\eta \rightarrow \mu^+ + \mu^-$

amplitude. The known branching ratios for the important final states in η decay (on mass shell) are inspected, with the conclusion that only the 2γ intermediate state contributes significantly to the unitarity sum. The lower limit for branching ratio for this $\mu^+ + \mu^-$ decay mode is found to be 1.1 $(10)^{-3}$. (J.F.P.)

29488 COMPARISON OF ELASTIC ELECTRON–PROTON SCATTERING CROSS SECTIONS WITH SOME THEORETICAL PREDICTIONS. Goitein, M.; Dunning, J. R. Jr.; Wilson, Richard (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 18: 1018-22(June 5, 1967).

It is pointed out that the best theoretical predictions are not adequate to describe the detailed functional dependence of the cross sections on the four-momentum transfer. Theoretically predicted data are directly compared with the experimental data on elastic electron–proton scattering. (J.F.P.)

29489 DISPERSION RELATIONS AND THE PROTON–NEUTRON MASS DIFFERENCE. Cottingham, W. N.; Gibb, J. (Univ. of Birmingham, Eng.). Phys. Rev. Lett., 18: 883-4(May 15, 1967).

A sum rule was previously derived for the proton–neutron mass difference as calculated in second-order theory. The derivation depended on unsubtracted dispersion relations being written for the forward virtual photon Compton scattering amplitude. It was also argued previously that one of the dispersion relations given does in fact require a subtraction. It is shown that if a subtraction is needed in the dispersion relations then the usual second-order perturbation theory will diverge. (J.F.P.)

29490 LOCAL CURRENT ALGEBRA AND MAGNETIC MOMENTS. Weyers, Jacques (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 1033-5(June 5, 1967). (SLAC-PUB-306).

A very simple calculation of the nucleon magnetic moments based on the local SU(3) ⊗ SU(3) algebra and the angular-momentum condition of Dashen and Gell–Mann is presented. (J.F.P.)

Weak

Refer also to abstract 29519.

29491 (ITF-67-4) ON EXISTENCE OF A SOLUTION OF THE BETHE–SALPETER EQUATION IN A CASE OF LEPTON INTERACTIONS. [PART] I. Jatsun, V. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 38p. Dep.

The solution of the integral equation for the trace of the scattering amplitude for lepton scattering via the vector meson interaction is considered. The analytical properties of the solution regarded as a function of the parameter g^2 are studied. (J.F.P.)

29492 RADIATIVE CORRECTIONS TO β DECAY AND THE QUANTUM NUMBERS OF FIELDS UNDERLYING CURRENT ALGEBRA. Johnson, K. (Massachusetts Inst. of Tech., Cambridge); Low, F. E.; Suura, H. Contract AT(30-1)-2098. Phys. Rev. Lett., 18: 1224-5(June 26, 1967). (MIT-2098-334).

It is shown that the second-order radiative corrections to $\pi^+\beta$ decay are finite, provided one assumes a V–A interaction and a current algebra constructed from spin-$\frac{1}{2}$ SU(3) triplet fields with the quantum numbers of Λ, Ξ^0, and Ξ^-, or Ω^-, Ξ^0, and Ξ^-, and $\frac{1}{3}$-integral hypercharge; or, equivalently, V + A together with p, n, Λ or p, n, Ω'^+ triplets. (auth)

29493 PHOTON DECAY OF THE Ω^- HYPERON. Gronskii, V. K.; Satsunkevich, I. S. Vestsi Akad. Navuk B. SSR, Ser. Fiz.-Mat. Navuk, No. 2, 126-7(1966). (In Russian).

The decay $\Omega^- \to \Xi + \gamma$ is considered. In the expression found for the total probability of this decay, the axial part of the current makes the major contribution to the probability. (J.F.P.)

29494 SYMMETRY SCHEME FOR WEAK INTERACTIONS OF LEPTONS. Yndurain, F. J. (Univ. of Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 99-102(Mar.-Apr. 1967).

A symmetry scheme for the weak interactions of leptons is proposed. The scheme generalizes previous models and incorporates the rules for conservation of lepton quantum numbers as well as μ-e universality. Some previous models are interpreted as remainders of the symmetry when the electromagnetic interactions are turned on. (auth)

29495 CURRENT ALGEBRAS AND WEAK INTERACTIONS. Cabibbo, N. (CERN, Geneva. Univ., Aquila, Italy). pp 146-72 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

In the discussion of applications of current algebra to weak interactions, zero-energy theorems which relate the matrix element of a process $A \to B + \pi$ in the limit of vanishing meson (π) momentum, to that of the corresponding process $A \to B$ are mainly discussed. An outline of the theory for weak interactions and current algebra, a discussion of the zero-energy theorem, and applications to leptonic and nonleptonic decays of mesons (K) are discussed. (J.F.P.)

29496 WEAK BOSONS; DECAY AND PRODUCTION. Yamaguchi, Y. (Tokyo Univ.). pp 691-710 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.) New York, Academic Press, 1966.

A brief survey of weak bosons is given. Weak interactions, mesons (W), weak current, the decay of the W into two pseudoscalar mesons, W decay into a pseudoscalar meson and a vector meson, W decay into an antiproton and a neutron, the SU(3) limit, and the quark model are covered. Also covered are the search for mesons (W), and the absolute decay rate. (J.F.P.)

29497 W-BOSON CONTRIBUTION TO THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. Brodsky, Stanley J.; Sullivan, J. D. (Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-515. Phys. Rev., 156: 1644-7(Apr. 25, 1967). (SLAC-PUB-242).

The contribution of the intermediate vector boson to the muon anomalous moment is calculated in the ξ-limiting formalism. It is found that $\Delta\kappa_\mu = \Delta[(g_\mu - 2)/2] = (g_W{}^2/8\pi^2)\,(M_\mu/M_W)^2\,[2(1-\kappa_W)\ln\xi + 10/3]$, where $\sqrt{2}\,(g_W/M_W)^2 = G_F$ is the Fermi weak coupling constant and κ_W is the W anomalous moment. For $\kappa_W = 0$, and ξ chosen according to the prescription of Lee, this contribution is numerically $\Delta\kappa_\mu \cong -1.0 \times 10^{-6} \cong -0.8(\alpha/\pi)^3$. (auth)

29498 MODEL FOR THE $\Delta I = \frac{1}{2}$ RULE. Michel, F. Curtis (Rice Univ., Houston, Tex.). Phys. Rev., 156: 1698-1702 (Apr. 25, 1967).

It is shown that a modification of the Cabibbo theory leads to identical results concerning the leptonic decays of hyperons but additionally contains the $\Delta I = \frac{1}{2}$ rule. The $\Delta I = \frac{1}{2}$ rule so obtained is weakly broken, but the deviations are not inconsistent with experiment. (The estimated rate for $K^+ \to \pi^+\pi^0$ is somewhat less than experimentally observed.) The model differs from Cabibbo's theory in that G_V (β decay)/G_V (muon decay) = 1 rather than $\cos\theta = 0.966$. Branching ratios of the intermediate bosons are estimated. (auth)

29499 NEUTRINO OR ELECTRON ENERGY NEEDED FOR TESTING CURRENT COMMUTATION RELATIONS. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.); Gilman, Frederick J. Contract AT(11-1)-68. Phys. Rev., 156: 1598-1602(Apr. 25, 1967). (CALT-68-99).

For small leptonic invariant 4-momentum transfer q^2, the minimum neutrino or electron energy needed to test current commutation relations is investigated. It is found that at laboratory energies of order 5 BeV, it is reasonable to start trying to check the equalities or inequalities implied by the current algebra. (auth)

29500 VECTOR-MESON DOMINANCE AND CURRENT ALGEBRA IN THE PARITY-VIOLATING NONLEPTONIC DECAYS OF K MESONS AND HYPERONS. Sakurai, J. J. (Univ. of Chicago). Phys. Rev., 156: 1508-10(Apr. 25, 1967). (COO-264-353).

As far as the parity-violating nonleptonic decays of K mesons and hyperons are concerned, many of the results obtained from the algebra of currents can be understood in a completely trivial manner using vector-meson dominance without recourse to the current commutation relations. In particular, it is shown that the current-algebraic approach applied to an octet Hamiltonian supplemented by the hypothesis of the universal spurion coupling leads to exactly the same physical consequences as the K*-dominance model of Lee and Swift. It is also indicated how a vector-meson-dominance model of nonleptonic decays may emerge out of a current-current interaction involving neutral as well as charged currents. (auth)

29501 AMBIGUITIES IN MASS EXTRAPOLATION VIA PARTIALLY CONSERVED AXIAL-VECTOR CURRENTS AND THE $K \to 2\pi$ DECAYS. Kisslinger, L. S. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 18: 861-3(May 15, 1967).

It is pointed out that if more than one meson (π) is taken off the mass shell, there exists within this same framework alternative prescriptions which give different results. This is illustrated by considering the $\Delta I = \frac{1}{2}$ rule for the $K \to 2\pi$ decay. For this decay, it is shown that the previous conclusion that the $\Delta I = \frac{1}{2}$ rule is a consequence of a current–current form for the weak Hamiltonian and PCAC depends upon the prescription, and that with an alternative and probably preferable procedure this is not a valid conclusion. The matrix element $K_{3\pi}$ for the $K \to 2\pi$ decay models with an assumed current–current Hamiltonian is considered. (J.F.P.)

29502 ISOTOPIC SPIN SELECTION RULES AND THE DECAY $K_L \to 2\pi$. Veltman, M. (Univ. of Utrecht). Phys. Lett., 24B: 587-9(May 29, 1967).

Recent measurements performed on the decay of $K_L \rightarrow 2\pi^0$ have shown that the final 2π state in $K_L \rightarrow 2\pi$ contains a rather large I = 2 admixture. Some properties concerning the I-spin behavior of the CP-violating interactions are derived under the following assumptions: (1) The final 2π state in $K_L \rightarrow 2\pi$ is pure I = 2. (2) $K_L \rightarrow 2\pi$ (I = 0) is forbidden. (3) The CP-conserving non-leptonic strangeness changing interactions obey the rule $\Delta I = 1/2$. (4) The C-conserving electromagnetic interactions obey the rule $\Delta I = 0$ or 1. (L.B.S.)

29503 SYMPOSIUM ON WEAK INTERACTIONS, LAKE BALATON, HUNGARY, 31 MAY–5 JUNE 1966. Acta Phys. Acad. Sci. Hung., 22: 1-328(1967). (CONF-660565).

The conference included 31 complete papers. Separate abstracts were prepared for 29 papers. Abstracts of two papers appeared previously in NSA as 21: 27364 and 27453. (J.F.P.)

For abstracts of individual papers see: 29475–29478, 29504, 29506–29510, 29523–29525, 29535, 29574–29576, 29601–29607, 29613, 29636, 29637, 29917, and 30034.

29504 NEUTRINOS, GRAVITY, AND COSMOLOGY. Marx, G. (Roland Eoervoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 22: 59-64(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The observation of the soft cosmic neutrino and neutretto background, predicted by different cosmological theories, may be observed efficiently only with the help of reactions having no energy threshold. A new method is suggested making use of local gravitational fields. (auth)

Strong (General)

Refer also to abstracts 29589, 29638, and 30051.

29505 (ITF-66-3) RECENT PROGRESS IN MESON AND BARYON SPECTROSCOPY. Rosenfeld, A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1966. 37p. Dep.

Previous data on resonance production from polarized proton interactions are displayed in the form of Argand diagrams, and the characteristic behavior of resonances is reviewed. Resonances as Argand circles, Argand diagrams for π + p scattering, states with spin $7/2$, other new states and Regge recurrences are covered. The discussion of mesons includes isospin-0, -1 mesons and the Deck effect, and isospin-$1/2$ mesons (κ). (J.F.P.)

29506 HOT MODEL OF THE UNIVERSE AND THE ELEMENTARY PARTICLES. Zeldovich, Y. B. (Academy of Sciences, Moscow). Acta Phys. Acad. Sci. Hung., 22: 51-8 (1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The recent radio-astronomical observations strongly support the hot model of the universe. The implications of this model are discussed, and, in particular, an estimation is given for the number density of the quarks. (auth)

29507 RECENT RESULTS FROM THE QUARK MODEL. Socolow, R. H. (CERN, Geneva). Acta Phys. Acad. Sci. Hung., 22: 129-49(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The basic ideas and methods of the quark model of the elementary particles, and the main results of the model, including the new applications to high energy scattering are summarized and partly discussed in detail. Also the quark models of weak interactions are briefly mentioned. (auth)

29508 BARYON MODEL AS A TETRAHEDRON OF QUARKS AND ONE ANTIQUARK. Zeldovich, Y. B.; Sakharov, A. D. (Academy of Sciences, Moscow). Acta Phys. Acad. Sci. Hung., 22: 151-2(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

A baryon model consisting of 4 quarks and one antiquark is proposed. (auth)

29509 MASS FORMULAS FOR MESONS AND BARYONS IN THE QUARK MODEL. Zeldovich, Y. B.; Sakharov, A. D. (Academy of Sciences, Moscow). Acta Phys. Acad. Sci. Hung., 22: 153-7(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

A unified mass formula is given, linear both for mesons and baryons. The spin-spin interaction and the annihilation interaction of strange quark pairs is proposed to be much weaker than that of nonstrange quark pairs. (auth)

29510 CROSS SECTION OF QUARK PRODUCTION. Gerstein, S. S. Acta Phys. Acad. Sci. Hung., 22: 163-4(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

It is shown that in certain circumstances the cross section of quark production may be much larger than that predicted on the basis of the statistical model. (auth)

29511 FIXED POLES IN THE COMPLEX ANGULAR-MOMENTUM PLANE. Oehme, Reinhard (Univ. of Chicago). Phys. Rev. Lett., 18: 1222-4(June 26, 1967).

It is shown that fixed poles in the l plane are forbidden for strong interactions unless there exist moving branch points with very specific properties. A fixed pole with protective cuts is considered as a possible model for diffraction scattering. (auth)

29512 EULER ANGLES FOR THREE AND FOUR IDENTICAL PARTICLE SYSTEMS. II. RELATIONS BETWEEN TWO SETS OF ANGULAR MOMENTUM FUNCTIONS. Proriol, J. (Institut de Physique Nucleaire, Lyon). Nucl. Phys., A98: 196-205(1967).

Some relations which are useful in passing from the gyroscopic functions $D^{l}_{mk}(\alpha,\beta,\gamma)$ to the products of spherical functions which are eigenfunctions of the angular momentum operator are presented. Also the inverse relations are given. These relations are used to estimate a correction of the energy levels of the helium atom and to calculate a mean value for the decay of a resonance. (auth)

29513 EULER ANGLES FOR THREE AND FOUR IDENTICAL PARTICLE SYSTEMS. I. A DETERMINATION OF THE EULER ANGLES AND APPLICATIONS TO SOME ANGULAR DISTRIBUTIONS FOR FOUR-BODY DECAYS. Proriol, J. (Institut de Physique Nucleaire, Lyon). Nucl. Phys., A98: 177-95(1967).

By a new method, the third Euler angle for a three identical particle system is obtained. All particles are treated on the same level. The Euler angles are chosen for the Li atom and for a four identical particle system. A relation is given for an angular distribution connected with the decay of a resonance into four identical spinless particles. The angular distribution of a pion emitted from the proton-antiproton annihilation into four particles is also studied. (auth)

29514 LECTURES ON BOOTSTRAPS. Zachariasen, F. (California Inst. of Tech., Pasadena. Univ., Copenhagen). pp 86-151 of Recent Developments in Particle Physics. Moravcsik, Michael J. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A discussion of the bootstrap hypothesis, its domain of applicability, its limitations, consequences, and difficulties is presented. Included in the discussion are dynamical versus elementary particles, practical bootstrapping, and bootstraps and symmetries. (J.F.P.)

29515 ALGEBRAIC DESCRIPTION OF HADRON MATTER AND ITS OBSERVATIONAL IMPLICATIONS. Ne'eman, Yuval (California Inst. of Tech., Pasadena. Tel Aviv Univ., Israel). pp 51-85 of Recent Developments in Particle Physics. Moravcsik, Michael J. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The review of the theory of strongly interacting matter is based upon the synthesis of the ideas that the kinematics of strong interactions are entirely given by the application of unitarity, Lorentz invariance, and the analyticity postulates with respect to the S-matrix, and that the dynamics of hadrons in all known interactions are otherwise fixed by a ninefold dynamical observable unitary spin. Unitary spin, the broken symmetry, symmetries generated by the algebra of current components, sum rules for the currents and their moments, and hadron band spectra are considered. (J.F.P.)

29516 PION–PION SCATTERING IN A K-MATRIX MODEL INCORPORATING CROSSING SYMMETRY. Cordes, J. G. (Cambridge Univ., Eng.). Phys. Rev., 156: 1707-18(Apr. 25, 1967).

A crossing-symmetric generalization of the K-matrix formalism is developed and used to construct a model for π-π scattering. The full amplitude satisfies elastic unitarity in the s channel and has the correct singularity structure at the elastic thresholds in the t and u channels. The two parameters present in the model are determined by requiring approximate satisfaction of the crossing relations in the neighborhood of the symmetry point. The resulting p-wave phase shift exhibits a resonance with mass about 800 MeV and width about 250 MeV. The f^0 is not reproduced. This s-wave scattering lengths in the I = 0 and I = 2 channels are (a_0, a_2) = (−0.67, −0.30) and the effective Chew–Mandelstam coupling constant is found to be 0.18. (auth)

29517 EXPERIMENTAL EVALUATION OF QUARK AND REGGE-POLE MODELS FOR HIGH-ENERGY SCATTERING.

Barger, V.; Durand III, L. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 156: 1525-31(Apr. 25, 1967). (COO-881-92).

Relations among high-energy cross sections derived from the simple quark model are found to be in systematic disagreement with existing experimental data. Regge-pole models with only SU(3)-symmetric vertices do not share these difficulties. The use of quark-model vertices with the Regge-pole model leads to the unsuccessful relations of the simple quark model. (auth)

29518 MULTIPARTICLE PRODUCTION IN HIGH-ENERGY COLLISIONS. Huang, Kerson (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 156: 1555-63(Apr. 25, 1967). (MIT-2098-284).

The "incoherent-droplet" model proposed earlier is solved for the general case of multiparticle production in high-energy hadron collisions. For small transverse momenta the result is equivalent to taking the invariant square matrix element to be $C \exp[-(n/Nk_0^2) \sum_{i=1}^{n} q_i^2]$, where q_i is the magnitude of the transverse momentum of the ith final particle, n is the total number of particles in the final state, N is an increasing function of energy, otherwise unspecified, and k_0 is a constant. Independent of the choice of parameters in the model, it is found that in the high-energy limit two of the heaviest final particles share equally almost all of the available energy. Parameters of the model can be so chosen as to reproduce the experimental constancy of the average transverse momentum and the total cross section. The simplest choice leads to the prediction that the average multiplicity increases logarithmically with the total cm energy. Illustrative examples of energy and angular distributions are given. (auth)

29519 STRONG AND WEAK INTERACTIONS. PRESENT PROBLEMS. 1966 International School of Physics Ettore Majorana, a CERN-MPI-NATO Advanced Study Institute, Erice, Italy, June 19-July 4, 1966. Zichichi, A. (ed.). New York, Academic Press, 1966. 874p. $26.50.

The lectures and seminars are included in 18 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 29421, 29466, 29467, 29481, 29482, 29495, 29496, 29520-29522, 29526, 29527, 29541, 29542, 29584, 29610, 29614, and 29627.

29520 RELATIVISTIC QUARK MODEL AS REPRESENTATION OF CURRENT ALGEBRA. Gell-Mann, M. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. pp 202-34 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The discussion of the relativistic quark model as a representation of current algebra covers current algebra of infinite momentum, relativistic representation of current algebra, the relation to approximate symmetry, and covariant formalism. Both the covariant and noncovariant formalism is used to describe a trivial model of mesons in which they are built of a free Dirac quark and antiquark. (J.F.P.)

29521 MODELS OF STRONG INTERACTIONS. Zumino, B. (New York Univ., New York). pp 315-58 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The presentation for models of strong interactions uses two descriptions: that of the nonrelativistic quark model and that of phenomenological Lagrangian theory. The wave functions of mesons and baryons, electromagnetic properties, relations among strong vertices, relations between cross sections, a brief description of U(6,6) theory, and medium-strong mass splittings are considered. (J.F.P.)

29522 REGGE POLES AND THE ALGEBRA OF CURRENTS. Cabibbo, N. (CERN, Geneva, Univ., Aquila, Italy). pp 359-77 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The theory of high-energy strong interactions is discussed based on the identification of an algebra of scalar and vector currents in the structure of the residue functions associated with Regge trajectories. (J.F.P.)

Strong (Baryon No. = 0)

29523 RELATIVISTIC QUARK MODEL WITH APPLICATION TO MESON DECAY RATES. Harte, J. (CERN, Geneva). Acta Phys. Acad. Sci. Hung., 22: 159-62(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The pseudoscalar and vector mesons are assumed to be quark-antiquark bound states. By using the Bethe-Salpeter equation, the wave functions of mesons are determined and, in turn, these wave functions are applied to calculate several meson decay rates. For the $\rho \rightarrow 2\pi$ decay $\Gamma = 200$ MeV is obtained which is roughly in agreement with the experimental value. (auth)

29524 APPLICATIONS OF CURRENT ALGEBRAS. Renner, B. (Cambridge Univ., Eng.). Acta Phys. Acad. Sci. Hung., 22: 281-4(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The relations of current algebras to strong interaction dynamics are studied by considering charge-current commutators between meson states and the vacuum. (auth)

29525 REMARKS ON THE WOLF $\pi\pi$ PHASE SHIFTS AND THE CALCULATION OF g_A/g_V RATIO FROM ADLER $\pi\pi$ SUM RULE. Pisut, J. (Katedra Teoretickej Fyziky UK, Bratislava). Acta Phys. Acad. Sci. Hung., 22: 297-300(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The consistency of pion-pion phase shifts recently proposed by G. Wolf with dispersion relations is briefly mentioned. Using these phase shifts the g_A/g_V ratio is calculated from Adler $\pi\pi$ sum rule. The calculated value is $g_A/g_V = 1.08$. Some possibilities of reducing the discrepancy between the calculated and experimental values are discussed. (auth)

29526 MESON RESONANCES. Fiorini, E. (Univ., Milan). pp 378-467 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

A review of the experimental situation with regard to the existence and quantum numbers of resonances with baryon number zero is given. The topics covered are recent results on the existence and quantum numbers of mesons and kinematic effects. (J.F.P.)

29527 POSSIBLE TEST AND SOME APPLICATIONS OF REGGE POLES. Srivastava, Y. N. (Northeastern Univ., Boston). pp 684-90 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

Some questions and recent results related to Regge poles are discussed. Only the basic results are presented. The topics covered are curvature of fermion trajectories as a test of Regge pole theory, background integral of the Regge representation, the use of Regge poles in the direct channel at low energies, and Reggeized bootstraps. (J.F.P.)

29528 NUCLEON-ANTINUCLEON CHARGE-EXCHANGE SCATTERING USING U(6,6) AND THE ABSORPTION MODEL. Migneron, J. H. R.; Moriarty, K. (Imperial Coll. of Science and Tech., London). Phys. Rev. Lett., 18: 978-80(May 29, 1967).

The results of a calculation based on the absorption model with U(6,6) symmetry imposed at the peripheral vertices of the reaction $p + \bar{p} \rightarrow n + \bar{n}$ at 3.0, 3.6, 5.0, 6.0, 7.0, and 9.0 GeV/c are presented. Agreement within the experimental errors is obtained at all energies for $-t \leq 0.6$ $(GeV/c)^2$. At larger momentum transfers there are discrepancies as expected for a peripheral-type model. (auth)

29529 NONFORWARD SUPERCONVERGENCE RELATIONS. Klein, Stanley (Brandeis Univ., Waltham, Mass.). Phys. Rev. Lett., 18: 1074-6(June 12, 1967).

A superconvergence relation for πp scattering is saturated for a range of t with an infinite number of mesons of all spins and nondegenerate masses. (auth)

29530 INELASTICITY AND UNIQUENESS OF THE SCATTERING MATRIX. Martin, A. (CERN, Geneva). Phys. Lett., 24B: 585-6(May 29, 1967).

It is shown, in the framework of the Mandelstam representation, that the $\pi\pi$ scattering amplitude is entirely fixed if the "overlap function," as defined by Van Hove, is known above a certain energy. (auth)

29531 PARTIAL CONSERVATION OF TENSOR CURRENTS AND VECTOR-MESON COUPLINGS IN BROKEN UNITARY SYMMETRY. Ghose, P. (Indian Association for the Cultivation of Science, Calcutta). Phys. Rev., 156: 1585-8(Apr. 25, 1967).

It is suggested that the eight conserved vector currents generated by SU(3) gauge transformations, to which vector mesons are coupled, are related to the divergence of antisymmetric tensor currents. This leads to generalized Goldberger-Treiman relations. $\Gamma(\phi K\bar{K}) \simeq 3.3$ MeV is predicted, in agreement with experiments (3.3 ± 0.6 MeV). (auth)

29532 S-MATRIX APPROACH TO INTERNAL SYMMETRIES. Blankenbecler, R. (Univ. of California, Santa Barbara); Coon, D. D.; Roy, S. M. Phys. Rev., 156: 1624-36(Apr. 25, 1967).

A criterion for internal symmetry in an S-matrix framework is formulated and a method to determine permitted internal symmetries by a rigorous application of unitarity and crossing is developed. Applying this method to particular cases, amplitude relations are found that are usually obtained by assuming invariance under certain Lie groups. For example, applications are made to isotopic-spin invariance in the coupled pion-kaon system and to SU(3) invariance in the scattering of the 8 pseudoscalar mesons. Other higher symmetries are discussed. By clarifying the essential assumptions which go into dynamical derivations of symmetries, the method permits more general derivations from weaker assumptions. It is shown that the usual dynamical schemes used to derive internal symmetries essentially assume most of their results and in addition contain many inessential assumptions. For example, the bootstrap approach requires the existence of poles and the bootstrap conditions, whereas this approach requires neither. (auth)

29533 HIGH-ENERGY np CHARGE-EXCHANGE SCATTERING AND ONE-PION EXCHANGE. Byers, Nina (Univ. of California, Los Angeles). Phys. Rev., 156: 1703-7(Apr. 25, 1967).

It is shown that the "droplet" model with long-range π exchange included can account for the observed np charge-exchange differential cross sections in the GeV region for $0 < -t < 0.5$ $(GeV/c)^2$. The very steep rise in $d\sigma/dt$ for $-t < 0.02$ $(GeV/c)^2$ is due to long-range π exchange and is similar to the steep rise near $t = 0$ in elastic scattering of charged particles due to the Coulomb interaction. From the droplet-model viewpoint, π exchange can be identified only in large-impact-parameter collisions. For smaller-impact-parameter collisions, the model differs from the absorptive OPE model; however, the resulting amplitudes also have the one-pion pole at $t = \mu^2$. The reaction $np \rightarrow pn$ in the GeV region is remarkable in that it may be the only reaction in which the effect of long-range π exchange can be easily seen. In elastic scattering, long-range π^0 exchange scattering is small compared to diffraction scattering, and is masked by Coulomb effects. It might be observed in high-precision measurements of np elastic scattering. In $\bar{p}p \rightarrow \bar{n}n$, the effect of long-range π^- exchange is likely to be more accessible to experimental observation. The anomaly near $t = 0$ due to π exchange may tend to vanish at high energies, due to the rapid decrease of the π-exchange amplitude with increasing energy. Fits to the data in the region $0.1 < -t < 0.5$ $(GeV/c)^2$ indicate strong spin dependence in np and $\bar{p}p$ charge exchange. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 30074.

29534 (DESY-67/11) SUM RULES IN PERTURBATION THEORY. Kramer, G.; Meetz, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1967. 24p. Dep.

Sum rules derived from isospin current algebra are examined in perturbation theory for nucleons interacting with neutral pseudoscalar mesons and isovector pions. It is shown that the well-known sum rules for electromagnetic isovector form factors of nucleons and pions are correct in zero and second order of the meson-nucleon coupling constant. (auth)

29535 MIXING EFFECTS IN BARYON SPECTROSCOPY. Maiani, L. (Istituto Superiore di Sanita, Rome. Univ., Florence). Acta Phys. Acad. Sci. Hung., 22: 291-5(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The role of the (20, L = 1) states in describing the low-energy weak and electromagnetic parameters of the stable baryons and of the $\frac{3}{2}^+$ resonances is discussed. (auth)

29536 N*(1518) AS A REGGE POLE AND PION-NUCLEON SCATTERING PHASE-SHIFT IN $T = \frac{1}{2}$, $J = \frac{3}{2}$ STATE. Basu, Bamandas; Harun-ar Rashid, A. M. (Atomic Energy Centre, Dacca, Pakistan). Z. Phys., 203: 8-12(1967).

The D_{13} pion-nucleon scattering phase-shifts are calculated using the Khuri representation suitably modified in order to exhibit explicitly the isolated nucleon pole in the u-channel. The results of the calculation are compared with the phase-shift analysis of Roper. (auth)

29537 CHIRAL-ALGEBRA CONDITIONS ON πA AMPLITUDES. Maiani, L. (Istituto Superiore di Sanita, Rome. Univ., Florence); Preparata, G. Nuovo Cim. (10), 49B: 237-41(June 11, 1967).

It is shown that the only sum rule involving genuine πN amplitudes is in fact the Adler–Weisberger sum rule. By considering the commutation relations of an axial charge with an axial dipole, a sum rule connecting the isovector magnetic moment of the nucleon with π N amplitudes and amplitudes referring to axial production of π on nucleons is derived. By approximately evaluating the neutrino amplitude in the previous sum rule, a result is obtained which points to a fair consistency of the rule and thus of the hypothesis involved. (J.F.P.)

29538 SUPERCONVERGENCE RELATION AT BACKWARD ANGLE. Otokozawa, J. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Nuovo Cim. (10), 49B: 214-17(June 11, 1967). (RLO-1388-511).

The boson–baryon backward scattering amplitude is considered as a further test for the superconvergence relation at backward scattering. The dominance of the Regge pole N and $N_{\frac{3}{2}}^{*}$ (33 resonance) is assumed for π N backward scattering. (J.F.P.)

29539 CHARGE EXCHANGE AND ASSOCIATED PRODUCTION IN THE ALGEBRA OF FACTORIZED RESIDUES. Ne'eman, Yuval (Tel-Aviv Univ., Israel. Southwest Center for Advanced Studies, Dallas); Reichert, John D. Phys. Rev. Lett., 18: 1226-30(June 26, 1967).

The $[SU(3) \otimes SU(3)]_S$ algebra of factorized Regge-pole residues is applied to obtain relations between meson-baryon and baryon-baryon exchange processes. This theory reproduces results previously obtained only in the "quark model" and gives new relations as well. (auth)

29540 O(4) AND FORWARD PRODUCTION PROCESSES AT HIGH ENERGIES. Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev. Lett., 18: 1212-14(June 26, 1967).

A method is sketched for writing down invariant amplitudes which give the leading contributions of families of Regge trajectories of definite O(4) class (at zero momentum transfer). The method is illustrated by the case $\pi + N \rightarrow \rho + N$, where it leads to definite predictions (in spite of unequal masses) for the leading term in each helicity amplitude. (auth)

29541 REGGE POLES IN HIGH-ENERGY SCATTERING. Phillips, R. J. N. (Atomic Energy Research Establishment, Harwell, Eng.). pp 268-314 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

Regge phenomenology is considered. The Regge poles are postulated, and their predictions are examined and compared with experiment. Moving poles, the Sommerfeld–Watson transformation, signature, high-energy kinematics, t-channel poles, πN scattering, characteristic Regge properties, and properties of other models are discussed. Also discussed are non-Regge effects, the one-pole cases of $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow \eta^0 + n$, the two-pole case for KN and $\bar{K}$N charge exchange, SU(3) for π, η, K, and $\bar{K}$, and other interactions with boson Regge poles. (J.F.P.)

29542 PHENOMENOLOGY OF RESONANCES AND PARTICLE SUPERMULTIPLETS. Barbaro-Galtieri, A. (Univ. of California, Berkeley). pp 468-564 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966. (UCRL-17054).

Baryon resonances with strangeness zero are reviewed, and meson and baryon multiplets are classified into supermultiplets according to experimental data. Resonances with baryon number +1, and strangeness –1 and –2 and the possibility of strangeness +1 resonances are discussed. Also the present situation regarding particle supermultiplets is considered. (J.F.P.)

29543 SERIES OF HYPERON RESONANCES IN THE STATIC BOOTSTRAP MODEL. Noga, M. (Comenius Univ., Bratislava). Nucl. Phys., B2: 80-92(1967).

The Dashen–Frautschi off-the-mass-shell bootstrap technique is used for the calculation of strong-form factors in the static model. It is proved that these form factors are analytic functions with analytic properties prescribed by the S-matrix theory and fulfil the unitarity condition if and only if a series of hyperons with $I = J \pm \frac{1}{2}$ exists and if certain relations among masses and among coupling constants of these hyperons are fulfilled. The mass spectrum for this series is found. The results obtained in this method are compared with those predicted by the Lie-group structure describing the strong coupling model. The hyperon resonance with $I = 2$ and $J = \frac{3}{2}^+$ is discussed in some detail and theoretical predictions derived are compared with experimental data. The agreement is satisfactory. (auth)

29544 NEW CONSIDERATIONS ON THE STATISTICAL MODEL. II. APPLICATION TO p-WAVE π-N SCATTERING. Bourrely, C. (Faculte des Sciences, Marseille). Ann. Inst. Henri Poincare, Sect. A, 6: 255-65(1967). (In French).

A new method was suggested by J. Mandelbrojt and S. Mandelbrojt to replace in an unambiguous way the cutoff procedure often used in field theory. An application to the Chew–Low model for P-wave pion–nucleon scattering is investigated. With the source function evaluated by this procedure and without arbitrary param-

eters, it is found that the (3,3) resonance is obtained at 1230 MeV and a (1,1) resonance is predicted at 1420 MeV. (auth)

29545 MODEL FOR LOW-ENERGY PION–NUCLEON SCATTERING. Mani, H. S.; Tomozawa, Yukio; Yao, York-Peng (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 18: 1084-6(June 12, 1967).

A model satisfying current algebra and partial conservation of axial-vector currents, under certain approximations is proposed. The model leads to good fit with the experimental values for the low-energy π-N scattering parameters. (auth)

29546 THRESHOLD KN* PRODUCTION AND CURRENT ALGEBRA. Berman, S. M. (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 1081-3(June 12, 1967). (SLAC-PUB-303).

It is shown that many of the threshold features of the $K^+ + p \rightarrow K^0 + N^{*++}(1236)$ interaction, i.e., the value of the cross section, the slope with respect to energy, the cm angular distribution, and the N* decay angular distribution can be reasonably accounted for by current algebra and meson mass extrapolation arguments. (J.F.P.)

29547 EXPONENTIAL FIT TO HIGH ENERGY π^-p SCATTERING AT FIXED ANGLE. Burkhardt, H.; Ng, K. T. (Univ. of Birmingham, Eng.). Phys. Lett., 24B: 551-3(May 29, 1967).

$\pi^\pm$p Elastic scattering data in the region s, $-t$, $-u > 1$ GeV^2 are analysed in the center of mass system and shown to be consistent with an exponential decrease of differential cross section with energy at fixed angle. (auth)

29548 UNDERSTANDING "KINEMATIC EFFECTS." Stodolsky, L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 973-6(May 29, 1967). (BNL-11373).

A kinematic simplification is noted which greatly facilitates rough calculations for Drell–Hiida–Deck type low-mass enhancements for a particular pair in three-particle final states. The simplification allows the general features to be examined. The A_1 resonance production from $\pi + N$ interactions is considered. (J.F.P.)

29549 QUARK MODEL FOR MESON–BARYON PROCESSES. Joshi, G. C.; Bhasin, V. S.; Mitra, A. N. (Univ. of Delhi). Phys. Rev., 156: 1572-80(Apr. 25, 1967).

An SU(3)-invariant model of the elastic quark (Q) meson (pseudoscalar) scattering amplitude is proposed in the spirit of an impulse approximation, for the description of meson-baryon scattering and production processes involving both the positive- and negative-parity baryons looked upon as 3Q composites. The mesons are looked upon as "elementary" particles, rather than $Q\bar{Q}$ composites. The positive-parity baryons are assumed to belong to the 56 representation of SU(6), and the negative parity ones to the (70,3) representation of SU(6) $\otimes$ O(3). The results for the scattering and production amplitudes are expressed in the form of sum rules connecting physically interesting processes. Several sum rules are obtained for the elastic scattering amplitudes which agree with the Johnson-Treiman and Lipkin relations. For production processes within the 56 of baryons, some of the results, which do not agree with SU(6) or SU(6)$_W$, are at least not disfavored by experiment compared with the latter. A number of relations among amplitudes connecting production of negative-parity baryonic states are also obtained, but these cannot be tested experimentally at this stage. A slight variant of the model, in which the initial meson is replaced by a spurion octet, reproduces in a natural way all the known sum rules for nonleptonic decays of Σ, Λ, and Ξ. For the Ω^- decay to $\Xi\pi$ and $\Xi^*\pi$ systems, the predictions of the model are, however, different from those of SU(6) or of partially conserved axial-vector current with equal-time commutators. (auth)

29550 PERTURBATION THEORY AND THE MASS SUM RULE FOR THE BARYON OCTET. Swift, Arthur R. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 156: 1729-38(Apr. 25, 1967). (COO–881-93).

Many dynamical derivations of the Gell-Mann–Okubo mass formula for the baryon octet assume that the symmetry-violating interactions can be treated to first order in perturbation theory. The validity of this assumption is tested by a detailed evaluation of second-order effects. A pole model with no free parameters contributes the major portion of the second-order effect; final-state scattering and other corrections are argued to be small. The second-order mass shifts are found to be 200 MeV or more. Since the second-order mass shifts are as large as the first-order shifts, the conclusion is that derivations of the mass splittings based on first-order perturbation theory must be considered as little more than restatements of the pure group-theoretic derivation. (auth)

29551 SHAPE OF THE N*(1236) RESONANCE. Michael, C. (Rutherford Lab., Chilton, Eng.). Phys. Rev., 156: 1677-84 (Apr. 25, 1967).

Corrections to the Breit-Wigner shape of the N*(1236) resonance are calculated using analyticity and inelastic unitarity incorporating the Nπ and N*π channels in a propagator formalism. This method, which includes only a right-hand cut and which evaluates the effect of bubble insertions in the propagator, is motivated by the rigorous results which have been proved for the nucleon. It is argued that even though background and left-hand cuts have been neglected, it is the inclusion of inelasticity that enables the P_{33} phase-shift data to be reproduced, even at energies well above resonance. The structureless-vertex decay model with a Breit-Wigner propagator gives an N* shape too asymmetric, and inclusion of an inelastic channel with an analytic propagator serves to correct this. Assuming N*π as the only inelastic channel, the $N^{*++}N^{*++}\pi^0$ coupling is estimated as 170 ± 50, where the unknown behavior of the vertices far off the mass shell causes the uncertainty. This estimate can be compared with about 75 from relativistic SU(6), and 136 using Adler-Weissberger techniques. The P_{33} partial-wave amplitude constructed on this model has a left-hand pole which simulates the effect of the neglected nucleon-exchange short cut, and which tends to lie too far left and with too large a residue. The application of the method to other resonances and bound states is discussed. (auth)

29552 SOME CONSEQUENCES OF SU(3) AND CHARGE-CONJUGATION INVARIANCE FOR K-MESON RESONANCES. Kane, G. L. (Univ. of Michigan, Ann Arbor). Phys. Rev., 156: 1738-41(Apr. 25, 1967).

Implications of invariance of strong interactions under SU(3) and charge conjugation are investigated for K-meson resonances (i.e., systems which are not eigenstates of C). It is pointed out that the charge-conjugation eigenvalue of the neutral nonstrange members of multiplets is determined by the decays (mesonic or electromagnetic) of the strange members. The K'(1320), K'(1420), and K'(1800) are considered as examples. Possibilities for study of symmetry breaking and particle mixing in kaon resonance decays are mentioned; they may provide practical methods for studying symmetry breaking. (auth)

29553 SU(3) SUM RULES FOR MESON–NUCLEON CHARGE-EXCHANGE REACTIONS. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 156: 1522-4(Apr. 25, 1967). (COO–881-89).

Assuming that the dominant mechanism for high-energy meson–nucleon charge-exchange scattering is the exchange of I = 1 members of SU(3) octet meson states, the sum rule

$$\frac{d\sigma}{dt}(K^-p \rightarrow K^0n) + \frac{d\sigma}{dt}(K^+n \rightarrow K^0p) = \frac{d\sigma}{dt}(\pi^-p \rightarrow \pi^0n) + 3\frac{d\sigma}{dt}(\pi^-p \rightarrow \eta n)$$

is derived and discussed. (auth)

29554 BROKEN-SYMMETRY SUM RULES AND THE ALGEBRA OF CURRENTS. Copley, L. A.; Masson, D. (Univ. of Toronto). Phys. Rev., 156: 1564-7(Apr. 25, 1967).

A general method is developed for obtaining first-order broken-symmetry sum rules for form factors using the algebra of currents. It is found that these sum rules are the same as the corresponding ones derived group-theoretically provided that the same or analogous physical assumptions are made in both methods. This is illustrated by a derivation of the Muraskin-Glashow sum rules for strong baryon–meson coupling constants. (auth)

29555 RECIPROCAL BOOTSTRAP OF THE N AND N* USING THE STATIC-MODEL BETHE-SALPETER EQUATION. Biswas, S. N.; Balazs, L. A. P. (Univ. of California, Los Angeles). Phys. Rev., 156: 1511-14(Apr. 25, 1967).

The Bethe-Salpeter equation is written down for the static model of πN scattering. This equation satisfies unitarity exactly in the elastic region, but includes at least some inelasticity at higher energies. It is solved below the inelastic threshold by using the Noyes technique, and then making a Pagels-type approximation. It is applied to the reciprocal bootstrap problem of Chew, where N* exchange is assumed to provide the dominant force for binding the N, and N exchange for giving rise to the N*. Experimental values are used for the crossed-channel masses and couplings. The cutoff is adjusted to give the correct position for the direct-channel nucleon pole. This gives an output N* mass and residues which are in rough agreement with experiment. (auth)

29556 COUPLING-CONSTANT SUM RULES FROM FIXED-MOMENTUM-TRANSFER DISPERSION RELATIONS. Biswas, S. N.; Dhar, J.; Saxena, R. P. (Univ. of Delhi). Phys. Rev., 156: 1515-17(Apr. 25, 1967).

Fixed-momentum-transfer dispersion relations for the process $\pi + N \rightarrow \rho + N$ are considered. Noticing that two of the invariant amplitudes decrease faster than 1/E for large energy E, two sum rules were obtained involving the coupling constants $g_{NN\pi}$, $g_{N^*N\pi}$, $g^{(1)}_{NN\rho}$, $g^{(2)}_{NN\rho}$, $F^{(1)}_{N^*N\rho}$, and $F^{(2)}_{N^*N\rho}$. Using experimental information,

$F^{(1)}_{N^*N\rho} = -2.84$ and $F^{(2)}_{N^*N\rho} = 1.03$ were determined. These results are in agreement with the SU(6) values and are also consistent with the experimental analysis of Albright and Liu. (auth)

29557 RELATION AMONG THE πN AND KN CHARGE-EXCHANGE DIFFERENTIAL CROSS SECTIONS FROM THE SU(3) REGGE-POLE THEORY. Chen, Fei S. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 156: 1520-2(Apr. 25, 1967).

The SU(3) Regge-pole theory, applied to πN and KN interactions, is reinvestigated. With the simple constraints provided by the SU(3) relations on the scattering amplitudes, the relation among the πN and KN charge-exchange differential cross sections is found to be

$$\frac{d\sigma}{dt}(K^-p \to K^0n) + \frac{d\sigma}{dt}(K^+n \to K^0p)\Big|_{\text{same E, t}} = \frac{d\sigma}{dt}(\pi^-p \to \pi^0n) + \frac{3}{F_0^2}\frac{d\sigma}{dt}(\pi^-p \to \eta^0n)\Big|_{\text{same E, t}}$$

where $F_0 = 1$ for the exact SU(3). However, F_0 can be allowed to deviate from 1, and on the basis of the fit to the experimental data, we find that F_0 is not far away from 1. From the above relation, a prediction for $K^+n \to K^0p$ is possible in a straightforward way. (auth)

29558 STRUCTURE OF THE HIGH ENERGY CURRENTS. Frahm, C. P.; Ne'eman, Y.; Yellin, Joel (Tel-Aviv Univ., Israel). pp 2-14 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The algebra of vertex strengths in factorized Regge residues is applied to high-energy meson-baryon elastic forward scattering and to nucleon–nucleon elastic cross sections. The structure of the high-energy currents, which satisfy the commutation relation of $[U(3) \times U(3)]_8$ and the coupling of the 2^+ mesons to $_{(1,1)}\Theta_{\mu\nu}$ are investigated. (L.B.S.)

29559 MATTER, ANTIMATTER, AND THE ORIGIN OF GALAXIES. Harrison, E. R. (Univ. of Massachusetts, Amherst). Phys. Rev. Lett., 18: 1011-13(June 5, 1967).

Baryon inhomogeneities in the early high-density universe may account for the origin of galaxies. Any such inhomogeneity is amplified by baryon-pair annihilation as the universe expands and can eventually result in the formation of galaxies and anti-galaxies. This process is more efficient than the usual process which assumes that the initial conditions of a structural universe are density fluctuations. (auth)

29560 SUM RULES FOR PION–HYPERON SCATTERING. Shaw, Graham (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev. Lett., 18: 1025-7(June 5, 1967).

The forward sum rule for $\pi\Sigma$ scattering is shown to be inconsistent with the current algebra scattering lengths. A further class of dispersion-theory sum rule shows that the dynamics of the $^3/_2^+$ resonances cannot be dominated by baryon exchange. (auth)

29561 ALGEBRAIC STRUCTURE RESULTING FROM SUPER-CONVERGENCE RELATIONS. Bose, S. K.; DeCelles, P. C.; McGlinn, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev. Lett., 18: 873-6(May 15, 1967). (COO-427-62).

An algebraic structure for the classification of the particles and their couplings is investigated for the meson–baryon scattering case. Various sum rules are considered. (J.F.P.)

Strong (Baryon No. ≥ 2)

29562 (JINR-P1-3268) DISKRIMINATSIYA STATISTICHESKIKH GIPOTEZ PRI BLIZKIKH ZNACHENIYAKH X^2. (Discrimination of Statistical Hypotheses of the Values of X^2 of the Same Order). Kazarinov, Yu. M.; Kiselev, V. S.; Rozanova, A. M.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 19p. (In Russian). Dep.

A method was suggested for evaluating the probability of a first type error if one rejects the hypothesis of a larger value of χ^2 with the χ^2 difference of two hypotheses $\Delta\chi^2 \geq 10$ with a larger number of freedom degrees when the probabilities of hypotheses on the χ^2-criterion are of the same order. The problem is solved in two stages. First, in formulating the problem according to Neumann-Pirson the probability of the first type error is estimated for the case of fixed hypotheses (without the fitted parameters). Further, this result is used to obtain the majorized estimate of the probability of the first type error in the case of linear dependence of the hypotheses on the fitted parameters for which the ignorance of the exact hypothesis turns out to be unessential. The result can be used in the case of quasi-linear hypotheses as well. It was shown that for fixed hypotheses the probability P of the first type error does not exceed half of the probability of the fact that χ^2 with one freedom degree will not exceed the difference χ^2 of the hypotheses. In the case of hypotheses with linear dependence on the fitted parameters for P the estimate was obtained which takes into account the probability of additional fluctuation for the χ^2 minima difference due to the unknown parameters determined by the mathematical structure of the hypotheses. P can be evaluated analytically either by the Monte Carlo method or by the method presented. The evaluation of P was used to discriminate between solutions in the phase-shift analysis of nucleon-nucleon scattering at 630 MeV. In this case two of the three solutions obtained earlier were rejected with a $P \leq 0.1\%$ probability. The difference χ^2 of these solutions with χ^2 for the best of the solutions turned out to be 13.56 and 19.10 for the number of freedom degrees as large as 207. (auth)

29563 (UCRL-17571) BOUNDS FOR THE CORRECTION TO THE BORN TERM AND APPLICATIONS TO p–p SCATTERING FOR A GENERALIZED DISPERSION MODEL. Binstock, Judith (California Univ., Berkeley. Lawrence Radiation Lab.). May 3, 1967. Contract W-7405-eng-48. 41p. Dep. CFSTI.

Thesis.

A generalized dispersion model for the unitarizing correction to the Born term is given. (Only equal-mass, elastic scattering is considered.) The upper and lower bounds on this correction are explicitly given, in terms of the experimentally available direct-channel phase shifts. This model is shown to include as special cases the Chew-Arndt, MacGregor-Arndt (j_0 even), Scotti-Wong, and Kantor models. The main features of the model are analyticity (except for cuts from unitarity and crossing), specifications both of the number of fluctuations of the left-hand-discontinuity (LHD) of the correction term and of the asymptotic behavior of the correction term, and unitarity of the full partial-wave amplitude. A similar exploitation of the analyticity and unitarity of the full partial-wave amplitude is shown to yield a consistency condition relating the number of fluctuations of the LHD of the full partial-wave amplitude to the direct-channel phase shifts. The consistency condition is shown to have power as well as rigor, in that its application to p–p scattering data yields new information. (auth)

29564 METHOD OF SUMMATION OF DIAGRAMS IN APPLICATION TO SIMPLE REACTIONS INVOLVING DEUTERONS. Komarov, V. V.; Popova, A. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 483-93(Mar. 1966). (In Russian).

The method of summation of diagrams is applied to inelastic scattering of nucleons by deuterons. Analysis of the simplest diagrams allows the validity and accuracy of the approximate methods of solutions of nuclear problems to be determined, namely, the usual Born approximation, the distorted wave Born approximation, and the impulse approximation. The method of summation of diagrams is also illustrated for the analysis of inelastic scattering of deuterons by nuclei. (L.B.S.)

29565 Λ-NUCLEON SPIN–ORBIT FORCE AND THE Λ-^{4}He ELASTIC SCATTERING. Alexander, G.; Gal, A.; Gersten, A. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., B2: 1-7(1967).

The study of Λ-^{4}He low energy scattering is suggested as a means of obtaining information on the Λ–N spin-orbit force. The Λ-^{4}He elastic scattering and polarization behavior as a function of energy is calculated using the $_\Lambda$^{5}He binding energy and the properties of the p-shell hypernuclei. (auth)

29566 NEW CONSIDERATIONS ON THE STATISTICAL MODEL. I. THE SOURCE FUNCTION. Bourrely, C.; Mandelbrojt, J.; Pascale, J. (Faculte des Sciences, Marseille). Ann. Inst. Henri Poincare, Sect. A, 6: 245-54(1967). (In French).

A source function in the Chew-Low model is calculated from conditions on the two-nucleon potential by using a "canonical convergence procedure." Without the use of arbitrary parameters (such as a cutoff) and without introducing the mass of the nucleon, the source function is found to be negligible for $\omega > 6\mu$ (μ, mass of the π meson). (auth)

29567 LOW-ENERGY Λ-p SCATTERING AND THE HYPERTRITON BINDING ENERGY WITH SUMS OF SEPARABLE POTENTIALS. Schick, L. H. (Univ. of Southern California, Los Angeles); Hetherington, J. H. Phys. Rev., 156: 1602-10(Apr. 25, 1967).

The $_\Lambda$H^3 binding energy is calculated by finding the pole in the Λ-d doublet S-wave scattering amplitude. This amplitude is obtained from a multiple-scattering formalism of the Faddeev type. Each of the two-body interactions was represented as a sum of an attractive and a repulsive S-wave nonlocal separable potential of the Yamaguchi form. The Λ-N potentials were chosen to fit the scattering lengths and effective ranges obtained by Herndon, Tang, and Schmid (HTS) in a variation calculation. The N-N potential was adjusted to fit the deuteron binding energy and the triplet scattering length. Calculations with several sets of values for the free parameters are carried out. By making the Λ-N repulsive strengths infinite, fixing all three repulsive potential ranges

at 0.2 F, and varying the range of the N-N attractive potential, a value for the $_{\Lambda}H^{3}$ binding energy that agrees with that of the HTS calculation is obtained. (auth)

29568 STRONG INITIAL- AND FINAL-STATE INTERACTIONS IN NONMESONIC HYPERNUCLEAR DECAYS AND IN PARITY-VIOLATING N + N → N + N REACTIONS. Adams, J. Barclay (Stanford Univ., Calif.). Phys. Rev., 156: 1611-22 (Apr. 25, 1967).

A distorted-wave Born calculation is used to show that the strong initial- and final-state interactions in the nonmesonic hypernuclear decays, Λ + N → N + N, are of major importance, greatly suppressing certain transitions, and suggest the dominance of one-pion exchange in the explanation of hypernuclear decay rates. Weak exchange of heavier mesons is also suppressed by the strong interactions both in Λ + N → N + N—badly breaking any SU(3) symmetry of the reactions—and in the parity-violating N + N → N + N. It is shown that the decay rate of heavy hypernuclei provides a measure of the Λ-N correlation function at short distances in nuclear matter and should depend significantly on the existence of a hard core in the Λ-N strong interaction. (auth)

29569 K^{-}-d BREAKUP SCATTERING. Hetherington, J. H. (Michigan State Univ., East Lansing); Schick, L. H. Phys. Rev., 156: 1647-52(Apr. 25, 1967).

Cross sections for the reactions $K^{-} + d \rightarrow K^{-} + n + p$ and $K^{-} + d \rightarrow \overline{K^{0}} + n + n$ are calculated by means of the Faddeev equations and separable potentials. Kaon-nucleon interactions were based on either the Kim or the Sakitt scattering lengths. Derivations of the equations for these processes and of the technique for obtaining these cross sections after solving the integral equation for complex momenta are presented. The cross section for $K^{-} + d \rightarrow \overline{K^{0}} + n + n$ so calculated is somewhat larger than that obtained in recent experiments. (auth)

29570 HIGH-ENERGY DEUTERON CROSS SECTIONS: CHARGE-EXCHANGE EFFECTS. Glauber, R. J. (Harvard Univ., Cambridge, Mass.); Franco, Victor. Phys. Rev., 156: 1685-97(Apr. 25, 1967).

The effects of charge exchange in collisions of high-energy particles of isotopic spin ½ with deuterons are investigated. The diffraction approximation is used to express the deuteron charge-exchange cross section in terms of the elastic-scattering amplitudes of the neutron and proton and the deuteron ground-state wave function. Examinations are also made of the influence of the charge-exchange mechanism on the total cross section of the deuteron, the elastic differential cross section, and the summed angular distribution of scattering (elastic plus inelastic scattering with initial charges preserved). The important role played by double-scattering processes in shaping the differential cross sections of the deuteron is illustrated in a discussion of proton-deuteron elastic scattering at 2 BeV. Double scattering is shown to be the dominant collision mechanism at scattering angles which are not too close to the forward direction. The effect of the double charge-exchange process on the elastic differential cross section is shown to be small but of some significance in the angular range which is dominated by double scattering. The theory developed for charge-exchange reactions is applied to the K^{0} angular distribution which has been observed from K^{+}-deuteron collisions at 2.27 BeV/c. Estimates are found for the differential and integrated K^{+}-neutron charge-exchange cross sections, and for some related parameters. The effects of double collisions on these cross sections are relatively small and easily evaluated. The effect of the charge-exchange mechanism on the values of the pn, $\bar{p}n$, and $K^{\pm}n$ total cross sections which are reached indirectly via measurements on the deuteron is shown to be exceedingly small for momenta above ~2 BeV/c. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 29470.

29571 (JINR-E2-3279) EXTENSION OF $SU(6)_{w}$ TO NON-COLLINEAR PROCESSES. Ogievetskii, V. I.; Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 35p. Dep.

A relativistic symmetry group $SU(6)_{w}$ is proposed. It is isomorphic to SU(6), leaves the conventional free equations of motion invariant and is compatible with the crossing symmetry. The 36- and 56-plets are discussed and a rule for writing invariant amplitudes is given. The $SU(6)_{x}$ symmetry turns into the $SU(6)_{w}$ one for collinear configurations. (auth)

29572 (LYCEN-6727) THEORIE GRAPHIQUE DES COEFFICIENTS DE CLEBSCH-GORDAN, DES OPERATEURS IRREDUCTIBLES ET DES FACTEURS ISOSCALAIRES DANS SU_{3}. (Graphical Theory of Clebsch-Gordan Coefficients of Irreducible Operators, and Isoscalar Factors in SU_{3}. Castel, Boris (Lyon Univ. (France). Institut de Physique Nucleaire). Apr. 7, 1967. 96p. (In French). Dep.

Thesis.

After a brief resume of the results of group theory applied to SU_{3}, the graphical formalism of the Clebsch-Gordan coefficient, irreducible tensors, and rotation matrices is developed. A brief demonstration is given of the Wigner-Eckart theorem. The graphic structure of the isoscalar factors are utilized to find results of particular cases. The possibility of the graphic method is illustrated by taking up the problem of the increasing matrix in high energy reactions. In particular it is shown that the graphic treatment, which makes it possible to best visualize the physics problem, gives excellent demonstrations of results not mathematically obtainable. (tr-auth)

29573 (NP-16679) O RAZLOZHENII PRYAMOGO PROIZVEDENIYA NEPRIVODIMYKH PREDSTAVLENII POLUPROSTYKH ALGEBR LI NA NEPRIVODIMYE PREDSTARLENIYA. (On Expansion of Direct Products of Irreducible Representation of Semisimple Lie Algebras Into Irreducible Representations). Klimyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1966. 16p. (In Russian). Dep.

A direct product of irreducible representations of complex semisimple Lie algebras is considered. A condition for the highest weights of component representations which leads to a simple form for decomposition of a direct product of representations into irreducible representations is derived. Also, the classical algebras A_{l}, B_{l}, C_{l}, and D_{l} are considered. (auth)

29574 RELATIVISTIC SU(6) SYMMETRIES WITH INFINITE MULTIPLETS. Ruehl, W. (CERN, Geneva). Acta Phys. Acad. Sci. Hung., 22: 177-86(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The group P × SL(6,C) and its physical interpretation is discussed and the predictions which can be derived from the model are surveyed. In conclusion it is stressed that the theories with infinite multiplets of the type studied here encounter great difficulties connected with the violation of crossing symmetry. (auth)

29575 NONCOMPACT SYMMETRY GROUPS, UNITARY S-MATRIX, AND QUANTUM FIELD THEORY. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Acad. Sci. Hung., 22: 187-200(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The noncompact symmetry groups and their connections with field theory are studied. It is proven explicitly that in the symmetry with a noncompact group there exists no contradiction with the unitarity condition of the S-matrix. A method of describing the symmetry with a noncompact group by means of the apparatus of the local quantum field theory is suggested. Within the method the field operators satisfy the normal commutation relations, and the S-matrix is crossing-symmetrical. (auth)

29576 ON THE THEORY OF UNITARY REPRESENTATIONS OF THE SL(2C) GROUP. Dao Vong Duc; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Acad. Sci. Hung., 22: 201-19(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary,

The irreducible unitary representation of the noncompact SL(2,C) is discussed by a method based on the use of the homogeneous functions. The matrix elements of the finite transformations are calculated explicitly. The method is very convenient for applications in physics and the results of Gelfand and Naimark are obtained in a very simple way. (auth)

29577 PARTICLE SYMMETRY. Matthews, P. T. (Imperial Coll. of Science and Tech., London). Endeavour, 26: 63-7(May 1967).

The symmetrical arrangement for elementary particles is explained, and unusual properties of hypothetical quarks are described. Topics discussed include nuclear particles, relativistic invariance, baryonic charge and hypercharge, and unitary symmetry. (J.F.P.)

29578 GROUP SU_{3} AND ELEMENTARY PARTICLES. Macfarlane, A. J. (Syracuse Univ., N. Y.). pp 591-713 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

The role of the theory of groups and group representation in the physics of elementary particles is studied. Attention is focused on internal rather than space-time symmetries of particle

interactions but specific dynamic models are not considered. The relevant properties of SU(3) and its representations are discussed. The value of the experimental predictions that follow from the eight-fold way of classification at particles and resonant states according to the representations of SU(3) is derived and estimated. (L.B.S.)

29579 GROUP THEORY AND THE MANY-BODY PROBLEM. Moshinsky, M. (Univ. de Mexico, Mexico City). pp 289-377 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

Group-theoretical techniques which are effective for dealing with some many-body problems are pointed out. The topics discussed include the second quantization formulation of the many-body problem and its group theoretical interpretation; supermultiplet classification of the states; lowering operators and the matrix elements of the generators of the unitary group; the single orbital picture for a single shell of the harmonic oscillator; pairing plus quadrupole–quadrupole interactions as a model for central interactions; and spin-orbit coupling. The generators of the unitary and orthogonal groups and their commutation relations, Wigner coefficients of SU(3), and determination of the eigenstates for the L^2 interaction are discussed in the appendices. (L.B.S.)

29580 SUBSTITUTION GROUPS OF THE REPRESENTATIONS OF THE G_2 AND SU_3 GROUPS. Alishauskas, S. I.; Rudzikas, Z. B.; Yutsis, A. P. (Inst. of Physics and Mathematics, Vilnyus, USSR. Vilnyus State Univ., USSR). Dokl. Akad. Nauk SSSR, 172: 58-60(Jan. 1, 1967). (In Russian).

In view of the importance of groups G_2 and SU_3 for the theory of electron shells of atoms and for the theory of elementary particles, the authors discuss substitutions of the parameters of representations which leave the characters of these groups invariant. Use is made of earlier work dealing with similar substitutions for the SU_2 group and one case of substitution for SU_3. It is shown that such substitutions make up a group which is characteristic of the given Lie group and is isomorphic to the reflection group. This is done by finding substitutions for those parameters which leave invariant the eigenvalues of the Casimir operators. A list of substitutions under which the groups remain invariant is presented. Interpretations are presented for a number of the substitutions. The result can be useful in treatment of relations between particles and antiparticles. In general, advantage of their practical utility can be taken only in concrete calculations. (ATD)

29581 ON MASS SPLITTING IN LORENTZ-INVARIANT THEORIES. Berendt, G. (Freie Univ., Berlin). Acta Phys. Austr., 25: 55-7(Apr. 1967).

A statement closely related to O'Raifeartaigh's theorem, is derived using the method of group contraction, developed by Inönü and Wigner. (auth)

29582 CONTRACTION OF GROUP REPRESENTATIONS AND SUPERSELECTION RULES. Berendt, G. (Freie Univ., Berlin). Acta Phys. Austr., 25: 30-5(Apr. 1967).

It is shown that superselection rules may appear as a consequence of the requirement that the unitary representations of noncompact groups of a certain type be contracted towards unitary representations of the respective contracted groups. (auth)

29583 ON A GRAPHICAL METHOD FOR CLEBSCH-GORDAN COEFFICIENTS ISOSCALAR FACTORS AND ROTATION MATRICES FOR SU_3. El-Baz, E.; Castel, B.; Massot, J.-N.; Lafoucriere, J. (Univ., Lyon). Nucl. Phys., B2: 51-79(1967).

A graphical method is formulated here to streamline calculations in irreducible representations of SU_3. De Swart's work serves as an introductory mathematical basis to develop a graphical formalism for Clebsch–Gordan coefficients, isoscalar factors and rotation matrices in SU_3. The diagrammatic language thus obtained is used to give a shorter proof of the Wigner–Eckart theorem for SU_3, and to reach Ponzano's results for isoscalar factors in a much quicker way. (auth)

29584 HADRON AND LEPTON INTERNAL SYMMETRIES. Radicati, L. A. (Scuola Normale Superiore, Pisa, Italy). pp 129-45 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The internal symmetries of various interactions, their differences and similarities are briefly reviewed. Internal symmetry for leptons, algebra of the hadron vector current, and leptons and hadrons are covered. (J.F.P.)

29585 CALCULATION OF TRANSITION PROBABILITIES FROM NONCOMPACT DYNAMICAL GROUPS. Barut, A. O. (Univ. of Colorado, Boulder). Phys. Rev., 156: 1538-40(Apr. 25, 1967).

External electromagnetic interactions have been introduced into the formalism of noncompact dynamical groups describing all states of a quantum-mechanical system. Complete reduced matrix elements can be evaluated if the hadron levels are approximated as rotational and "vibrational" levels. The relation of the method to the S matrix and the algebra of currents is discussed. (auth)

29586 CALCULATION OF RELATIVISTIC TRANSITION PROBABILITIES AND FORM FACTORS FROM NONCOMPACT GROUPS. Barut, A. O.; Kleinert, Hagen (Univ. of Colorado, Boulder). Phys. Rev., 156: 1546-51(Apr. 25, 1967).

Relativistic transition probabilities and form factors were evaluated in closed form (in terms of hypergeometric functions) for a model of fundamental particles constructed on the unitary irreducible representation space of a noncompact dynamical group. Majorana-type equations were used to project out irreducible subspaces of the Poincaré group and to specify the transformation properties of the electromagnetic current. The magnetic moment of the spin-½ ground state in the simplest representation is $-½$, and the observed symmetry $G_E(t) = G_M(t)/\mu$ is obtained. (L.B.S.)

29587 REPRESENTATION DEPENDENCE OF SPONTANEOUS SYMMETRY BREAKING. Frishman, Y. (Stanford Univ., Calif.). Phys. Rev., 156: 1623-4(Apr. 25, 1967). (SLAC-PUB-232).

The dependence of spontaneous symmetry breaking on the representation is discussed. In case the usual symmetry-breaking condition is not realized, a modified condition may be found, which replaces the former in proofs of the Goldstone theorem. (auth)

29588 DYNAMICAL SYMMETRIES AND SYMMETRY ALGEBRAS. Leutwyler, H. (Univ., Bern); Sudarshan, E. C. G. Contract AT(30-1)-3399. Phys. Rev., 156: 1637-43(Apr. 25, 1967). (NYO-3399-80).

The interaction of three multiplets of particles is considered under the assumption that the members of each of these multiplets have the same mass and the same spin. The vertex self-consistency conditions lead to an algebraic structure involving the coupling matrices. This structure, referred to as a symmetry algebra and denoted by the symbol (N,n,ν), is characterized essentially by the numbers of particles N, n, and ν belonging to each one of the three multiplets and is independent of the particular underlying dynamics. A question of particular interest is whether dynamical self-consistency implies the existence of a symmetry group that leaves the interaction invariant. This problem is analyzed in detail for three particularly simple but instructive symmetry algebras. It is shown that the algebra $(N, n, \nu = Nn)$ corresponds to the case of maximal symmetry, the interaction being invariant under the group $U(N) \times U(n)$. The algebra $(N, n, \nu = Nn-1)$ is shown to have a solution only if $n = N$, in which case it corresponds to symmetry under the group U(N). Finally the particularly instructive algebra $(N = 3, n = 3, \nu = 3)$ is considered, which is shown to admit of three physically distinct solutions which correspond to invariance of the interaction under a three-parameter Abelian group, the orthogonal group in three dimensions, and the 24-element permutation group S_4, respectively. (auth)

29589 INFINITE MULTIPLETS AND THE HYDROGEN ATOM. Fronsdal, C. (Univ. of California, Los Angeles). Phys. Rev., 156: 1665-77(Apr. 25, 1967).

Attempts are made to construct infinite-component wave equations with mass spectra that are free of unphysical features. An example is given of a second-order relativistic wave equation whose mass spectrum, both the discrete and the continuous part is precisely the same as that of the nonrelativistic hydrogen atom. The nonrelativistic hydrogen atom is considered without any approximations. It is shown that the Schrödinger equation is equivalent to a nonrelativistic analog of Majorana-Nambu wave equations. The Hilbert space of all the states, including the continuum, is profitably and economically used as a representation space for a unitary, irreducible representation of the group SO(4,2). The dipole operator is an SO(4,2) generator. The theory is generalized to arbitrary frames of reference by application of Galilei transformations. The generators of Galilei transformations also belong to the SO(4,2) algebra. What results is a field theory of the hydrogen atom. The exact electromagnetic interaction, including all multipoles, takes the form of a local interaction between the electromagnetic field and the infinite-component hydrogen field. The significance of all this for hadron physics is discussed. (auth)

29590 SPONTANEOUS SYMMETRY BREAKING AND RELATED PROBLEMS. Miyazawa, Hironari. pp 22-50 of Recent Developments in Particle Physics. Moravcsik, Michael J. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Problems related to spontaneous symmetry breaking starting from a field theoretical Lagrangian are discussed. If the symmetry breaking of SU(3) is caused without any external driving term, the conclusions to be drawn and their agreement with observed facts are considered. The stability of self-consistent solu-

tions, conserved currents and massless bosons, and the contribution of bosons as intermediate states are covered. (J.F.P.)

29591 BOOTSTRAP THEORY OF SYMMETRY BREAKING. Frautschi, Steven. pp 152-96 of Recent Developments in Particle Physics. Moravcsik, Michael J. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The bootstrap theory of symmetry breaking includes the Dashen calculation of the neutron-proton mass difference, and a summary of the evidence for a pattern of octet dominance in all SU(3) symmetry breaking including the bootstrap theory of how this pattern arises in which the mass splittings within the $J = \frac{1}{2}^+$ baryon octet, and the $J = \frac{3}{2}^+$ decimet are shown. Also discussed are calculations of symmetry breaking in BBII and BΔII couplings (where II is the $J^P = 0^-$ octet), and a sketch of the bootstrap theory of electromagnetic and weak currents, in which a simple model for currents coupling to the $\frac{1}{2}^+$ octet and $\frac{3}{2}^+$ decimet is given. (J.F.P.)

29592 SU(2), SU(3)...,PART I. Gyorgyi, Geza (Central Physical Research Inst., Budapest). Fiz. Szemle, 17: 24-31 (Jan. 1967). (In Hungarian).

The SU(2) group occupies an important position in the development of mathematical physics; Klein and Sommerfeld applied the SU(2) transformations already to the classical kinematics of the gyroscope, recognizing their importance for quantum mechanics. From the viewpoint of their algebraic behavior, the SU(2) generators are closely related to the Jordan-Wigner fermion generating and absorbing operators. The concept of isospin, introduced by Wigner and Heisenberg, which became later an efficient tool for systematizing charge multiplets of nuclei and particles, was also based on SU(2) groups; similarly, through quasispin operators, the SU(2) concept played an important role in the development of the theory of superconductivity. The theoretical basis of these descriptors of the particle states is analyzed, discussing the concepts of spin, Jordan-Wigner operators, isospin, quasispin operators and the plane isotropic oscillator. (TTT)

29593 REDUCED MATRIX ELEMENTS OF GENERATORS OF THE "OSCILLATOR-LIKE" ("LADDER") REPRESENTATIONS OF U(N,N) ALGEBRAS IN THE SU(N) BASIS. Oliszewski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol., 31: 807-24(May 1967).

By simply generalizing the methods used previously for the explicit construction of the "oscillator-like" ("ladder") representations of the U(2,2) and U(3,3) algebras in a basis, in which the maximal compact, simple, SU(2) or SU(3) subalgebras, respectively, are diagonal (the "physical" basis), the reduced matrix elements of generators of U(N,N) algebras, corresponding to the reduction with respect to the maximal compact, simple, SU(N) subalgebra, in this class of representations, are calculated. The explicit knowledge of SU(N) Clebsch-Gordan coefficients is not needed in these calculations. (auth)

29594 PARTICLE DECAYS IN THE THEORY WITH NON-COMPACT GROUPS. Bokov, O. G.; Mihul, E.; Sredniawa, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 31: 875-81(May 1967).

The SL(2,C) group is considered as the internal symmetry group. The vector-coupling coefficients for the irreducible unitary representation of SL(2,C) are calculated. The matrix element for the decay of a spin-1 particle into two spinless particles is calculated. (auth)

29595 NONEXISTENCE OF SELF-CONJUGATE PARTICLES WITH HALF-INTEGRAL ISOSPIN. Lee, Huan (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev. Lett., 18: 1098-1101(June 12, 1967). (UCRL-17513).

It was recently shown by Carruthers in the framework of local field theory that the field operators corresponding to spinless bosons of a self-conjugate multiplet with half-integral isospin (SMHI) are nonlocal, in the sense that local commutativity between fields ϕ and ϕ^+ cannot be satisfied. This result is generalized to particles of any spin in an SMHI. The conclusion is that the requirement of local commutativity and the group structure of SU(2) do not allow the construction of spin fields of such particles. An analogous result is proved in the analytic S-matrix framework, where the requirement of isospin invariance and the usual crossing property entail that all scattering amplitudes involving any particles of an SMHI must vanish. (J.F.P.)

29596 INTRODUCTION TO LIE GROUPS AND LIE ALGEBRAS FOR APPLICATIONS TO PHYSICS. Toyoda, T. (Rikkyo Univ., Tokyo). Ark. Fys. Seminar Trondheim, No. 9, 1-174 (1966).

A series of lectures on Lie groups and algebras are presented. Various symmetry groups are considered. (J.F.P.)

29597 CORAL GABLES CONFERENCE ON SYMMETRY PRINCIPLES AT HIGH ENERGY. Fourth Conference, January 25-27, 1967. Perlmutter, Arnold; Kursunoglu, Behram (eds.). Miami Univ., Coral Gables, Fla., 1967. 259p. (CONF-670108). W. H. Freeman and Co., 660 Market St., San Francisco, Calif., $6.00.

Fifteen papers are included; separate abstracts were prepared for 11. Four papers were previously abstracted for NSA; see abstracts 21: 15275, 15338, 21287, and 25234. (L.B.S.)

For abstracts of individual papers see: 29468-29470, 29558, 29598, 29599, 29612, 29615-29617, and 29645.

29598 RETURN OF NONCOMPACT GROUPS. Kursunoglu, Behram (Univ. of Miami, Coral Gables, Fla.). pp 45-7 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The possibility of the SU(3,1) group as combination of internal and external symmetries is noted. The wave equation $(\Gamma_{\mu\nu}\gamma^\mu p^\nu - imc)\Psi = 0$ is presented, which was derived from rationalization of the Lagrangian of Born-Infeld. The nine tensor operators, $\Gamma_{\mu\nu}$ are generators of SU(3,1) and the γ^μ are the usual Dirac operators. These are 6×6 matrices, so the Ψ has 24 components and the wave equation has a spin structure of 1 and $\frac{1}{2}$. (L.B.S.)

29599 SUPERCONVERGENCE, CURRENT ALGEBRA AND THE LORENTZ GROUP. Fubini, Sergio (Univ., Turin). pp 106-21 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

Speculations are made concerning the unification of current algebra, superconvergence, and the field of unitary representations of the Lorentz group. A brief summary is first given of some general ideas about superconvergence and current algebra. The use of the unitary representations of the Lorentz group is then discussed. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstract 29957.

29600 (DESY-67/8) T-VERLETZUNG UND COMPTON-STREUUNG AM PROTON. (T-Invariance and Compton Scattering of Protons). Otto, Barbara (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1967. 66p. (In German). Dep.

The requirement of T invariance reduces the number of independent scattering amplitudes of P invariant proton Compton scattering from eight to six and correspondingly the number of independent polarization coefficients from 64 to 36. The 64 polarization coefficients are calculated in terms of the eight scattering amplitudes. The relations between them resulting from the T-invariance requirement are given in terms of general analytic expressions. These relations offer possibilities of experimentally testing T invariance by intensity or polarization measurement. However, a single measurement either of a left-right asymmetry of cross sections or of a polarization will not suffice, since none of the polarization coefficients are brought to vanish by the T-invariance requirement. In almost all of these possible tests, two scattering experiments are compared. They have identical kinematics, but in the second experiment the imposed polarizations of the primary particles must be exchanged for the measured polarization components of the secondary particles with respect to the first experiment (i.e., the polarization conditions are time reversed). A few of the more elementary tests are discussed in greater detail. Some of them require polarized proton targets. It is shown how experimental tests can be simplified considerably in a well known manner at energies below the meson π production threshold in the e^2-approximation of the scattering amplitude. No significant results can be expected from these tests, however, since the T-invariant Born approximation determines the behavior of the scattering amplitude in this energy range. (auth)

29601 POSSIBLE TESTS FOR THE VIOLATION OF PARITY AND TIME REVERSAL IN NUCLEI. Szymanski, Z. (Inst. for Nuclear Research, Warsaw. Univ. of Warsaw). Acta Phys. Acad. Sci. Hung., 22: 7-13(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The possible tests for the existence of weak nucleon-nucleon force and the violation of parity and time reversal in nuclei are discussed. (auth)

29602 RATIO C_A/C_V AND TIME REVERSAL INVARIANCE IN NEUTRON BETA DECAY. Conforto, G. (CERN, Geneva). Acta Phys. Acad. Sci. Hung., 22: 15-23(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31-June 5, 1966. See CONF-660565.

The existing data on the asymmetry coefficients of the various

correlations in the beta decay of free neutrons are applied to determine the A/V ratio and the relative phase A, V. It is shown that by using the above data the error of the generally accepted A,V value can be decreased by 25%. (auth)

29603 WEAK INTERACTIONS AND UNITARY SYMMETRY BREAKING. Moebius, P. (Univ., Vienna). Acta Phys. Acad. Sci. Hung., 22: 47-50(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

A model for leptonic decays is considered using unitary symmetry. For the calculation of matrix elements a special method of unitary symmetry-breaking is applied taking into account all corrections due to baryon mass differences. (auth)

29604 CP VIOLATION AND $\pi^+\pi^-$ INTERFERENCE IN NEUTRAL K DECAY. Nauenberg, M. (CERN, Geneva. Stanford Univ., Calif.). Acta Phys. Acad. Sci. Hung., 22: 71-6(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The elementary facts concerning the decay of neutral K mesons and the proposed CP violating interactions are briefly summarized. The recent interference experiments on the decay mode for a coherent mixture of K_1 and K_2 are discussed. (auth)

29605 THE STATUS OF CP INVARIANCE IN $K^0 \rightarrow \pi^+\pi^-$ DECAYS. Roos, M. (CERN, Geneva). Acta Phys. Acad. Sci. Hung., 22: 77-8(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The remaining possibilities to explain the long-lived $\pi^+\pi^-$ decays of K^0 mesons by CP invariant theories are examined in the light of two recent regeneration experiments at CERN. (auth)

29606 NONRELATIVISTIC QUARK MODEL. Morpurgo, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Acta Phys. Acad. Sci. Hung., 22: 105-28(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The classification scheme and decay properties of hadron states are investigated in the framework of the nonrelativistic quark model. The main successes and the unsolved difficulties of the model are presented indicating the future work which could be done to understand and exploit the nonrelativistic quark ideas. (auth)

29607 WEAK AND ELECTROMAGNETIC CURRENTS AND HADRON CLASSIFICATION. Preparata, G. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Acta Phys. Acad. Sci. Hung., 22: 285-90(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The various possibilities of representation mixing are discussed. In connection with magnetic moment relations it is shown that assuming "partial conservation of the tensor currents" and a vector meson–axial vector meson mixing, excellent agreement with experiment can be reached. (auth)

29608 SU(3) BREAKING AND CURRENT ALGEBRA IN NONLEPTONIC HYPERON DECAYS. Kumar, Arvind; Pati, Jogesh C. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 18: 1230-4(June 26, 1967).

It is shown that the corrections due to octet mass splitting and finiteness of the parity-nonconserving spurion lead to significantly better agreement of the prediction with experiments for the eight independent nonleptonic hyperon-decay amplitudes. Comments are made on the reasons for the validity of Lee-Sugawara sum rules for the parity-nonconserving and parity-conserving decays. (auth)

29609 SUPERCONVERGENCE RELATIONS FOR PHOTOPRODUCTION IN SU_3. Borgese, A. (Univ., Florence); Buccella, F.; Colocci, M.; Celeghini, E. Nuovo Cim. (10), 49B: 211-13 (June 11, 1967).

The set of sum rules following from the superconvergence of a particular photoproduction amplitude is studied under the assumption of SU(3) invariance. The result of the analysis is the necessity of including the $Y_1^8(1405)$ besides the octet and the decuplet in order to obtain the relation $\mu_p^a + \mu_n \rightarrow 0$ and a nonvanishing consistent solution for the anomalous magnetic moments of the baryons. In addition the prediction of a reasonable D/F ratio for the antibaryon–baryon–pseudoscalar meson coupling is obtained. (J.F.P.)

29610 IDEAS ABOUT CP. Glashow, S. L. (Harvard Univ., Cambridge, Mass.). Contract Nonr 3656(09). pp 235-67 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

A speculative discussion on the nature of the CP violation in meson (K^0) is given. Two possibilities are considered: that the CP-violating interactions are relatively strong and may give significant effects in other than weak processes, or that the CP violation finds its origin in the structure of weak interactions. An analysis of the neutral meson (K) system which is independent of the validity of TCP and which does not depend on a perturbative expansion in the weak coupling constant or on the possibility of writing the Hamiltonian as a sum of terms describing strong and weak interactions is presented. Included is a brief discussion of the implications of the unitary sum rule. (J.F.P.)

29611 TEST OF CURRENT ALGEBRA AND ELECTROMAGNETIC C NONINVARIANCE IN THE REACTIONS $\gamma + p \rightarrow \pi + N^*$ (1238) NEAR THRESHOLD. Barshay, Saul (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 18: 970-3(May 29, 1967).

What appears to be an experimentally feasible and fairly direct test of the new current commutation relations and hence of the existence of K_{μ_2} within the framework of the validity of the current algebra and PCAC hypotheses is pointed out. The test consists of a comparison of cross sections for the following interactions within ≤100 MeV of threshold: $\gamma + p \rightarrow N^{*++}(1238) + \pi^-$, $\gamma + p \rightarrow N^{*0}(1238) + \pi^+$, and $\gamma + p \rightarrow N^{*+}(1238) + \pi^0$. (J.F.P.)

29612 CURRENT ALGEBRA AND SUM RULES AT HIGH MOMENTUM TRANSFER. Bjorken, J. D. (Stanford Linear Accelerator Center, Calif.). pp 168-79 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

Studies of the implications of the locality assumptions of Gell–Mann's current algebra are discussed. Sum rules and inequalities for high-energy lepton processes at fixed momentum transfer are first treated. Of special experimental relevance are Adler's sum rule for neutrino reactions, and an inequality for inelastic electron (muon)–nucleon scattering. A critique is then given of the assumptions made in deriving these sum rules. It is argued that the hypotheses of asymptotic growth of certain S-matrix elements are the problem rather than the Schwinger terms. In particular, the general fixed-momentum-transfer relations have a more doubtful basis than their zero-momentum-transfer limits. The asymptotic behavior of perturbation amplitudes involving virtual photons or weak currents, is discussed, in particular, the radiative corrections to the vector β-decay amplitude. It is argued that to all orders of strong interaction these corrections, using the quark algebra, diverge logarithmically. For theories in which the isospin doublet has mean charge $-\frac{1}{2}$, the divergent term vanishes. (L.B.S.)

Applications (Strong)

Refer also to abstracts 29532 and 29552.

29613 DECAYS OF THE POSITIVE PARITY MESONS IN SU(6)W. Montvay, I.; Nagy, T. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 22: 221-7(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

$SU(6)_W$ invariant amplitudes are given for the decays of the 189 and 405 meson multiplets into two pseudoscalar mesons and into one vector meson and one pseudoscalar meson. The decay widths and branching ratios of the 2^+ mesons are calculated; the results obtained for 189 are closer to the experimental data. (auth)

29614 INTRODUCTION TO UNITARY SYMMETRY. Coleman, S. (Harvard Univ., Cambridge, Mass.). pp 78-128 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The discussion of unitary symmetry includes the search for higher symmetries, SU(3) and its representations, applications of SU(3) to hadron properties, and octet enhancement. (J.F.P.)

29615 INFINITE COMPONENT WAVE EQUATIONS. Nambu, Yoichiro (Chicago Univ., Ill.). pp 62-75 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The difficulties associated with the fully dynamical equations and largely kinematic equations (e.g. Bargmann–Wigner equation with U(6,6) group) are noted for obtaining a quantitative description of hadrons. An intermediate approach is taken, by considering simple relativistic wave equations having an infinite number of components, which are easily soluble and yield information about the mass spectrum and the matrix elements of observables, and therefore serve as dynamical equations for describing complex systems. A definite model is first considered with a certain compact symmetry group G_0 and degeneracy structure represented by a particular set S of representations. The group G_0 must contain the SU(2) or O(3) group corresponding to internal rotations of a system. Some specific examples are given dealing with models for hydrogen-like systems. A preliminary discussion is presented on

equations based on the harmonic oscillator model and the relevance of this model to the problem of hadrons. (L.B.S.)

29616 THE SOLUTION OF THE RELATIVISTIC DISCRETE MASS PROBLEM WITH INTERNAL DEGREES OF FREEDOM AND FURTHER DEVELOPMENTS. Barut, A. O.; Kleinert, H. (Univ. of Colorado, Boulder). pp 76-105 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The following problem is considered: to construct a theory of particles that treats kinematically the internal (I, Y, N, Q...) and the external quantum numbers (P_μ, J) on the same footing such that (i) all states of the system are correctly and minimally labelled in a single irreducible representation, (ii) $P_\mu P^\mu = M^2$ has a specified discrete spectrum, and (iii) the coupling of internal and external quantum numbers (symmetry breaking) is intrinsically included. An attempt is made to show that an algebraic relativistic and soluble theory of strong interactions can be constructed on the basis of a composite structure expressed group theoretically. The solution of the problems is first discussed in general terms, and new results are then presented for specific systems, concerning the calculation of form factors and amplitudes. (L.B.S.)

29617 SEARCH FOR HYPERONS AND BOSONS BELONGING TO HIGHER SYMMETRIES. Goldhaber, Gerson (Univ. of California, Berkeley). pp 190-236 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The extent to which evidence has been found for the existence of hyperons and bosons belonging to higher-symmetry groups is considered. The experimental situation is reviewed for the following: the existence of a $K\pi\pi$, $I = 3/2$ state; the K^+K^+, $I = 1$, $S = 2$; the $p\pi^+\pi^+$ mass peak at 1560 MeV; and the search for positive-strangeness hyperon resonances. (L.B.S.)

29618 DECAY RATES OF THE DECUPLET RESONANCES FROM O(3,1) x SU(3) DYNAMICS. DEFINITE SU(3) SYMMETRY BREAKING. Kleinert, Hagen (Univ. of Colorado, Boulder). Phys. Rev. Lett., 18: 1027-9(June 5, 1967).

The simplest dynamical group including SU(3), O(3,1) ⊗ SU(3), is used to describe the decay widths of the $j^P = 3/2^+$ decuplet resonances. SU(3) breaking comes in naturally (and uniquely) through the mass differences in the multiplet. The only two parameters of the theory were fixed in an independent fit of the $I = 3/2$ baryon decay rates for different spins. The agreement with experiment is excellent. (auth)

29619 O(4) SYMMETRY AND REGGE-POLE THEORY. Freedman, Daniel Z.; Wang, Jiunn-Ming (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 863-7(May 15, 1967).

A more general and elegant explanation of families of Regge trajectories is studied. According to this explanation, the existence of Regge families follows because, as a general consequence of Lorentz invariance, scattering amplitudes at zero values of the Mandelstam invariants have a special invariance property. The little group of the Poincaré group is considered for the process in which momenta $p_1 + p_2 \rightarrow p_1' + p_2'$. It is shown that a much simpler formation of the symmetry can be given in terms of the compact group O(4), which is identified as the little group in the unphysical region $t = 0$, $0 \leq s \leq 4m^2$. The general formulation of the O(4) symmetry in the presence of spin and its specific application to NN scattering are outlined. (J.F.P.)

Quantum Field Theories

Refer also to abstracts 29178 and 29575.

29620 (IS-T-166) CALCULATIONS OF DECAY CURVES FROM MASS DISTRIBUTIONS. Nelson, Ann McDonald (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 75p. Dep. CFSTI.

Thesis.

A uniform treatment of stable and unstable particles in quantum field theory was presented by McEwan. A modification of this approach which leads to a considerable simplification in the formulas for an unstable particle wave packet described in terms of the particle's mass distribution (characterized generally by a mean mass and width) is discussed. Numerical calculations of decay curves are given for various mass distributions with the purposes of defining the range of validity of the exponential decay law and determining the effect of the mass distribution threshold. (auth)

29621 (JINR-E2-3289) EXAMPLE OF AN INFINITE-COMPONENT LOCAL FIELD WHICH ANNIHILATES THE VACUUM. Stoyanov, D. Ts.; Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. Dep.

The well-known theorem, that the annihilation of the vacuum vector by a local field $\phi(x)$ implies the vanishing of the two-point function $\langle 0|\phi(x)\phi^*(y)|0\rangle$ is based essentially on the assumption that $\phi = \{\phi^\alpha\}$ transforms under a finite dimensional representation of the "index Lorentz group" SL(2,C). An example is given of an infinite-component free field with a decreasing mass spectrum, for which the above assertion is not true. In this example both commutators or anticommutators for the quantization of the field, can be used independently of whether the spin is integer or half-integer. (auth)

29622 (JINR-P2-3200) K TEORII POLYA S BESKONECHNYM MUL'TIPLETOM V SIMMETRII SU(2,2). (On the Field Theory With Infinite Multiplets in the SU(2,2) Symmetry). Cao Chi (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 15p. (In Russian). Dep.

Two series of degenerate unitary representations of the group SU(2,2) (the principal and the supplementary ones) were found previously. The reduction $SU(2,2) \supset \{SU(2) \otimes SU(2) \otimes U(1)\}_p$ where p is the four-momentum of particles and the classification of particles according to the irreducible representations of the maximal compact subgroup were also given. The vertex of the interaction of an infinite multiplet with a singlet field is considered. The expression of a "unique propagator" of an infinite boson and fermion multiplet is given. The true propagator of a particle with definite spin can be obtained from the "unique propagator" with the help of projection operators. Besides it is shown by using the "unique projection" that in many cases the field theory with infinite multiplets leads to convergent diagrams while they are divergent in the conventional field theory. (auth)

29623 (JINR-P2-3270) MODEL' KVANTOVOI TEORII POLYA BEZ UL'TRAFIOLETOVYKH RASKHODIMOSTEI. (Model of Quantum Field Theory Without Ultraviolet Divergences). Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep.

The previously constructed four-dimensional unitary relativistic model of quantum field theory without ultraviolet divergences is generalized in the case of the nonzero rest masses of spinor particles. Previously the rest masses of all the particles were assumed equal to 0. (auth)

29624 (NP-16779) GUELTIGKEIT DER QUANTENELEKTRODYNAMIK BEI WEITWINKEL-ELEKTRONENPAARERZEUGUNG. (Validity of Quantum Electrodynamics for Wide-Angle Electron Pair Production). Rohde, Martin (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1967. 61p. (In German). Dep.

An experiment on wide-angle electron pair production by the reaction $\gamma + C \rightarrow C + e^+ + e^-$ was performed to investigate the predictions of quantum electrodynamics at small distances. In contradiction to earlier experiments the result is consistent with theory up to an invariant mass M of the pair of 545 MeV/c^2, the best fit to the obtained ratio R of experimental to theoretical yield linear in M being $R = 0.95 \pm 0.04 - (0.4 \pm 1.1) \times 10^{-4}$ M. (auth)

29625 REPRESENTATION OF STATES IN THE QUANTUM FIELD THEORY. Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 170: 71-4 (Sept. 1, 1966). (In Russian).

In order to investigate the general properties of the S matrix for an arbitrary spin value, the dynamic system consisting of certain noninteracting quantum fields, characterized by generalized operator functions was examined. A normalized Hilbert space, related to the space of the beam state of noninteracting particles and antiparticles was considered, using the nuclear theorem of L. Schwarz for the multiparticle generalization; the vectors of the generalized state were derived from an arbitrary complex number, the vacuum state and the specific transformation properties. It is intended to continue the study by investigating the relativistically invariant elements of the S matrix. (TTT)

29626 LAGRANGIAN FORMALISM FOR MASSIVE RARITA-SCHWINGER FIELDS WITH SPIN 5/2. Kawakami, A. (Tokyo Univ. of Education). Nucl. Phys., B2: 33-50(1967).

The Lagrangian formalism for a massive Rarita-Schwinger field with spin 5/2 is investigated. An attempt is made to construct Lagrangians from which one can derive, by means of the variational principle, all the supplementary conditions as well as the Dirac-type equation for this field. It is shown that such Lagrangians do not exist, if it is required that they contain the field variables and their first order derivatives only, and that the symmetry nature with respect to the tensor suffices of the field be assumed from the outset. In view of this Lagrangians which contain the field variables and their derivatives up to the second order are proposed. Such Lagrangians constitute a 9-complex parameter family, whose members transform among themselves

under certain linear transformations for the field variables. The relativistic quantization is carried out for this field by the Umezawa–Takahashi method. The usual P*-symbol method leads to the Feynman rules to evaluate S-matrix elements. The minimal electromagnetic interaction of this field is also discussed, and it is shown that S-matrix elements do not depend on the parameters mentioned above. It is expected that the formalism can be straightforwardly extended to the case of higher-spin fields. (auth)

29627 RECENT DEVELOPMENTS IN THE THEORY OF MAGNETICALLY CHARGED PARTICLES. Zumino, B. (New York Univ., New York). pp 711-30 of Strong and Weak Interactions. Present Problems. Zichichi, A. (ed.). New York, Academic Press, 1966.

The discussion of the theory for magnetically charged particles includes the quantization condition, rotational invariance, and a nonrelativistic version of the Schwinger arguments for a precise definition of the operations to be performed. (J.F.P.)

29628 THE FORMULATION OF QUANTUM ELECTRODYNAMICS WITH STRONG LORENTZ CONDITION. II. INTERACTION PICTURE. Lukierski, J. (Univ. of Wroclaw). Acta Phys. Pol., 31: 905-28(May 1967).

The operator gauge transformations, changing covariant Feynman four-potentials A_μ^F into a variety of transverse potentials A_μ^{tr} are investigated. The gauge operator contains massless double-pole and three arbitrary functional parameters. The Landau-Khalatnikov, Valatin and Evans-Fulton gauges as particular cases are obtained. The contact terms, arising in different gauges, are discussed. The class of gauges, not modifying the usual Hamiltonian $j_\mu A^\mu$, and the class of generalized radiation gauges, with Coulomb contact term, are introduced. The spaces of states for different transversal gauges are discussed. (auth)

29629 DRESSED PARTICLE STATES IN LOCAL QUANTUM FIELD THEORY. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., 156: 1517-19(Apr. 25, 1967).

The approximate stationary quantum state which describes a dressed fermion elementary particle in a model theory of interacting local fields is reported. Showing no dependence on the infinite, positive, bare-mass constant, a finite, positive, dressed fermion mass value is obtainable. (auth)

29630 CRITIQUE OF AN APPLICATION OF THE N-QUANTUM APPROXIMATION. Halprin, Arthur (Univ. of Delaware, Newark). Phys. Rev., 156: 1552-3(Apr. 25, 1967).

The renormalization prescription given by Greenberg in his application of the N-quantum approximation to the Hurst-Thirring field is shown to be divergent. (auth)

29631 INFINITE MULTIPLETS AND LOCAL FIELDS. Fronsdal, C. (Univ. of California, Los Angeles). Phys. Rev., 156: 1653-64(Apr. 25, 1967).

An attempt is made to explore, by means of a simple model without internal symmetries, the qualitative features of "local" field theories of infinite multiplets, such as are encountered in relativistic SU(6) theory. A concept of nonderivative local interactions is defined, which leads to a generalization of conventional local field theory to include infinite representations of the spin group. Examples of these local interactions are examined in detail, and are found to have a number of attractive features. An investigation is made of locality in the sense of local commutation relations between the infinite-component fields. Although not conclusive, the study indicates that the conventional connection between spin and statistics gives the more physical theories, and that Fermi statistics are inconsistent with exact spin independence (invariance under the spin group). (auth)

29632 VECTOR FIELDS AND CURRENT COMMUTATORS. Boulware, David G. (Univ. of Washington, Seattle); Brown, Lowell S. Phys. Rev., 156: 1724-9(Apr. 25, 1967).

The relationship between the divergence condition for current operators coupled to vector fields and the equal-time commutator of these operators is described, and the assumptions that are necessary for this connection are made explicit. Both the cases of classical and quantized vector fields are treated in a manner that exhibits their similarity. (auth)

29633 RELATIVISTIC WAVE EQUATIONS AND FIELD THEORY FOR ARBITRARY SPIN. Tung, Wu-ki (Yale Univ., New Haven. State Univ. of New York, Stony Brook). Phys. Rev., 156: 1385-98(Apr. 25, 1967).

The possibility of formulating covariant field equations for particles of arbitrary spin and nonzero mass is considered. Using only the transformation properties of the single-particle states and the covariant fields under the Poincaré group, all possible covariant field equations are investigated which satisfy the following requirements: (i) neither "auxiliary fields" nor "subsidiary conditions" are used; (ii) solutions of the free-field equation correspond to a unique irreducible representation of the Poincaré group [characterized by (m,s)] and the discrete transformations C, P, and T. Using only equations which are homogeneous in the differential operator (except the mass term), it is shown that the only possible equations are those for spin 0, $\frac{1}{2}$, and 1. These consist of all the known equations plus a few new ones. The general formalism also allows equations which are not homogeneous in the differential operator. In this case strong evidence is again found that although new equations for spin 0, $\frac{1}{2}$, and 1 can be found, no equation for higher spin exists. It is shown, therefore, that the clear distinction between field theories of spin 0, $\frac{1}{2}$, and 1 and those of all higher spin already arises in their group structure quite independent of quantization or any dynamical scheme such as the Lagrangian formalism. It is shown that, if the requirements of unique mass and/or definite transformation properties under C and P are relaxed, then general classes of field equations exist for any spin s. Apparent difficulties associated with possible field theories based on these equations are briefly indicated. (auth)

29634 INTRODUCTION TO THE UNIFIED FIELD THEORY OF ELEMENTARY PARTICLES. Heisenberg, W. London, Interscience Publishers, 1966. 177p. 47s.

This publication comprises a series of lectures given at the University of Munich in 1965 on the following topics: The important experimental facts, The mathematical tools, The fundamental field equation, Methods of approximation, Solution of the simplest eigenvalue equations, Theory of coupling constants, Strange particles, Quantum electrodynamics, and Relations of unified field theory to phenomenological theories. (UK)

Scattering Theory

Refer also to abstracts 29532 and 29575.

29635 (JINR-P2-3301) ZAMECHANIYA O PRAVILAKH SUMM DLYA AMPLITUD KOMPTON-EFFEKTA. (Note on the Sum Rules for the Compton-Effect Amplitudes). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 9p. (In Russian). Dep.

Sum rules resulting from dispersion relations without subtracting for spin-dependent amplitudes of the nucleon Compton effect at $Q^2 = 0$ are considered. The determinations of the invariant amplitudes and the amplitudes in the center of mass system are given. (J.F.P.)

29636 DISPERSIVE SUM RULES FROM CURRENT ALGEBRA. Furlan, G. (Univ., Trieste, Italy); Rossetti, C. Acta Phys. Acad. Sci. Hung., 22: 239-80(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

One of the most successful and popular trends in the present approach to elementary particle physics seems to be, beside group theory, the method based on the so-called "current algebra." The main physical ideas and the most important results of this new approach as well as the present attitude toward still unsettled problems are recalled and summarized. As the subject is a rapidly developing one, the exposition will suffer from the imperfections of the theory, which is still at its heuristic stage. Namely, it is incomplete and the formulation is not the most elegant one, but, on the other hand, it offers many reasons for genuine enthusiasm, which it is attempted to make evident. (auth)

29637 LOCALIZATION OF RELATIVISTIC MICROPARTICLES IN SPACE AND TIME. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Acad. Sci. Hung., 22: 307-19(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

The theory in a formal way permits one-particle states which are localized in space with any degree of accuracy. This gives the possibility of formulating conditions of macroscopic causality directly for S-matrix. (auth)

29638 EXACT EQUATIONS FOR THE PERTURBED AMPLITUDE AND MASS AND COUPLING SHIFTS IN DISPERSION THEORY. Slansky, Richard C. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 156: 1532-7(Apr. 25, 1967). (UCRL-17047(Rev.)).

With the assumption that the unperturbed amplitude is known in the ND^{-1} representation, equations are derived for calculating the perturbed amplitude as a function of the variations of the left-hand singularities and the unitarity cuts. Exact formulas for mass and coupling-constant shifts of bound states of the unperturbed ampli-

tude are given, and the equations are then iterated to yield a perturbation theory. (auth)

29639 OFF-SHELL UNITARITY FOR TWO SPIN-1/2 PARTICLES. Sobel, M. I. (Brooklyn Coll., New York). Phys. Rev., 156: 1553-4(Apr. 25, 1967).

The implications of off-shell unitarity for the system of two spin-½ particles are examined. It is found that unitarity and time-reversal invariance imply a parametrization of the half-off-shell scattering amplitude which is identical to a formula previously found from a potential model. The amplitude is expressed in terms of the on-shell phase shifts and additional real quasi-phase-parameters. (auth)

29640 AMOUNT OF FOUR-PARTICLE PRODUCTION REQUIRED IN S-MATRIX THEORY. Dragt, A. J. (Univ. of Maryland, College Park). Phys. Rev., 156: 1588-93(Apr. 25, 1967).

It is shown that a knowledge of the two-particle scattering amplitude below inelastic threshold places restrictions on the amount of four-particle production at high angular momenta. Conversely, if there is no four-particle production, there is no elastic scattering. (auth)

29641 APPROXIMATE SOLUTION TO THE ND^{-1} EQUATIONS. Coulter, Philip W. (Univ. of Michigan, Ann Arbor). Phys. Rev., 156: 1594-7(Apr. 25, 1967).

The approximate solution to the ND^{-1} equations proposed by Pagels is examined. It is pointed out that the form of Pagels's equations is not actually new—it is precisely the same as has been used in numerical solutions of the exact ND^{-1} equations. The nature of the approximation is discussed in this context. Pagels's method is used to predict S-wave bound states in an attractive Yukawa potential and the results are compared with the numerical solution obtained in the usual manner. This calculation indicates that the approximation can give a reliable solution with an appreciable reduction in the time required for the calculation. Similar results can be obtained in the usual calculation for well-chosen mesh-point distributions. (auth)

29642 PHASE SHIFTS FROM THE BETHE–SALPETER DIFFERENTIAL EQUATION. Haymaker, Richard W. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 968-70(May 29, 1967). (UCRL-17498).

A new method of calculating phase shifts for a Bethe-Salpeter equation is presented. The scattering amplitude is calculated below elastic threshold using the differential equation and variational methods, and then continued to the elastic-scattering region to find phase shifts. (auth)

29643 POSSIBILITY OF AN INFINITE SEQUENCE OF REGGE RECURRENCES. Khuri, N. N. (Rockefeller Univ., New York). Phys. Rev. Lett., 18: 1094-8(June 12, 1967).

It is shown that a Regge trajectory, $\alpha(s)$, cannot have the property $\mathrm{Re}\alpha(s) \to +\infty$ as $s \to +\infty$ without leading to inconsistencies with two features of dispersion theory and Regge pole theory: that both $\alpha(s)$ and the reduced residue function, $\gamma(s)$, are analytic in the cut plane with one cut, and that they and the partial wave amplitude, $a(l,s)$, for $\mathrm{Re}l = -\frac{1}{2}$, are bounded for large $|s|$ by $\exp[|s|^{\frac{1}{2}-\epsilon}]$. (auth)

29644 SMALL-ANGLE SCATTERING AND A LOWER BOUND FOR THE SCATTERING AMPLITUDE AT LARGE ANGLES. Logunov, A. A.; Mestvirishvili, M. A. (Joint Inst. for Nuclear Research, Moscow). Phys. Lett., 24B: 583-5(May 29, 1967).

A relation is established between the lower bound for the large-angle scattering amplitude and the behavior of the diffraction and of the backward scattering peak widths. (auth)

29645 ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES. Martin, Andre (CERN, Geneva, Switzerland). pp 32-44 of Symmetry Principles at High Energy. Perlmutter, Arnold; Kursunoglu, Behram (eds.). San Francisco, W. H. Freeman and Co., 1967.

The analytic properties of scattering amplitudes are investigated within the framework of local field theory. An attempt is made to combine unitarity with the classical axiomatic results. (L.B.S.)

29646 SINGULARITIES FOR THE PROCESS OF MULTIPLE SCATTERING. Pham, Frederic (CERN, Geneva. CEN, Saclay, France). Ann. Inst. Henri Poincare, Sect. A, 6: 89-204 (1967). (In French).

As Coleman and Norton recently noticed, the phenomenological notion of "multiple scattering" allows a very simple interpretation of Landau singularities of the S matrix in the physical region, for processes with an arbitrary number of particles. Here this physical interpretation is deepened through a geometrical idea: Landau singularities are apparent contours. Using certain methods of differential topology, inspired by Thom, and developed, one shows that these apparent contours have in the physical region a much simpler structure than one would imagine. This gives the opportunity of formulating in a precise way the usual conjectures on the analyticity of the S matrix (distortion of the physical region, Cutkosky's rules, etc.), and of providing a simple link between these conjectures and the multiple scattering idea: thus Cutkosky's rules lead very directly to the factorization property of the S matrix for large timelike intervals. Still using the apparent contour idea, one studies systematically the "hierarchy" of the singularities for the various processes, thus supporting the conjectures through many mathematical consistency arguments. (auth)

Particle Accelerators

Refer also to abstracts 28329, 29416, and 29828.

29647 (BNL-11337) STEP-FUNCTION APPROXIMATIONS TO COS ntheta. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). Apr. 11, 1967. 11p. Dep. CFSTI.

It is shown how the step-function to imitate cos n θ should be specified to get the best harmonic approximation with N steps. (B.G.D.)

29648 (BNL-11364) PENNING DISCHARGE ION SOURCE FOR HIGH BRIGHTNESS. Bennett, G. W.; Turner, C. M. (Brookhaven National Lab., Upton, N. Y.). [1966]. 12p. (CONF-670307-46). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

The development, characteristics and emittance of the Penning discharge ion source used in the Cosmotron injector are described. The maximum value of brightness reported is 3×10^{12} mA cm^{-2} rad^{-2} at 78 mA total current, 23 keV beam energy. The results are superior to recent values for duoplasmatrons from various laboratories, except for total current. (auth)

29649 (BNL-11365) IMPROVEMENT OF HYDROGEN PUMPING CHARACTERISTICS OF PENNING DISCHARGE GETTER-ION PUMPS. Turner, C. M.; Marinuzzi, J. G.; Bennett, G. W. (Brookhaven National Lab., Upton, N. Y.). [nd]. 5p. (CONF-670307-48). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

Pumping hydrogen with Penning discharge getter-ion pumps at the flow rates normally encountered with accelerators employing hydrogen ion sources presents problems that do not appear when these pumps are employed on systems where the only gas load is that arising from surface degassing and residual leakage. These problems are thermal instability resulting from reemission of absorbed hydrogen, and deformation of the titanium cathodes with hydrogen absorption. This report outlines the pertinent considerations involved in modification of the design of the pumping elements of a standard 500 l/s pump (air rating), to increase by a factor of about 10 to hydrogen gas load the pump can handle without danger of thermal instability, and to virtually eliminate titanium deformation. Hydrogen gas loads of up to 50 atm cm^3/min can now be accommodated with a 500 l/s pump. While service life expectancy was previously limited to 2000-3000 hours by anode-cathode short circuit, it is presently limited by the ultimate hydrogen absorption capacity of the titanium. It is anticipated that life expectancies of up to 25000 hours can be realized with the 500 l/s pump at a hydrogen flow rate of 1 atm cm^3/min. (auth)

29650 (BNL-11423) SUPERPERIOD GRADIENT PERTURBATIONS IN THE AGS. Herrera, J. C.; Month, M. (Brookhaven National Lab., Upton, N. Y.). Apr. 24, 1967. 38p. Dep. CFSTI.

The theory of gradient perturbations in the AGS is applied to various superperiod distributions of quadrupoles. The following arrangements were specifically analyzed: the two quadrupoles presently used in the AGS at injection field, a group of four quadrupoles capable of correcting the β function distortion existing at injection field, and a distribution of ten quadrupoles designed to produce a shift in the ν value with a uniform change in the β function. The first order perturbation theory is also applied to an idealized AGS. (B.G.D.)

29651 (BNL-11441) STUDY OF A LARGE APERTURE AG SYNCHROTRON MAGNET. Dahl, P. F.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). May 15, 1967. 11p. Dep. CFSTI.

A study was made of an AG synchrotron magnet with a 12 inch good field aperture and a 7 inch magnet gap. This magnet was considered as part of a design study of a possible booster AGS for the Brookhaven AG synchrotron. (B.G.D.)

29652 (CALT-68-109) INJECTION TIMING AND RF CONTROL SYSTEM CALTECH 1.5 GeV ELECTRON SYNCHROTRON. Maloy, J. O.; Marshall, J. H.; Mullins, J. H. (California Inst. of Tech., Pasadena. Synchrotron Lab.). Nov. 1966. Contract AT(11-1)-68. 62p. Dep. CFSTI.

The electronic system used to control the injector and the radio frequency accelerating voltage of the CalTech Electron Synchrotron is described. The present solid-state system (1964-1965) replaces a vacuum-tube system which had been used since 1956. (B.G.D.)

29653 (CERN-67-7) THE PROGRAM "MARE" FOR THE COMPUTATION OF TWO-DIMENSIONAL STATIC MAGNETIC FIELDS. Perin, R.; van der Meer, S. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 20, 1967. 48p. Dep.

A computer program (MARE) is described which solves magnetic field problems in two dimensions by the method of finite differences and relaxation. Its primary characteristic is that the space is divided into two parts, the air-coil and the iron region, and they are heated separately. (B.G.D.)

29654 (CERN-67-8) POSSIBLE AND IMPOSSIBLE PHASE-SPACE TRANSFORMATIONS BY MEANS OF ALTERNATING-GRADIENT DOUBLETS AND TRIPLETS. APPLICATION TO THE TURN-OVER OPTICS OF AN RF SEPARATOR. Regenstreif, E. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 29, 1967. 50p. Dep.

In a previous paper (CERN 67-6(1967)) general analytic conditions for achieving simple phase-space transformations by means of an arbitrary multiplet are described. The conditions are applied to alternating-gradient doublets and triplets to investigate the practical feasibility of achieving transfer matrices by means of a doublet or a triplet. (B.G.D.)

29655 (CERN-67-9) AN INDUCTIVE BEAM MONITOR FOR THE EXTRACTED PROTON BEAM OF THE CERN SYNCHRO-CYCLOTRON. Hohbach, R.; Mango, S. (European Organization for Nuclear Research, Geneva (Switzerland)). Apr. 12, 1967. 44p. Dep.

An inductive beam monitor, as used for the extracted proton beam of the CERN synchrocyclotron, is described. It measures the number of protons passing through its aperture in a single burst, a second, or any other time interval, without interfering with the beam. It gives analogic and numerical displays of the result, and has easy and fast calibration facilities. (auth)

29656 (CERN-67-11) MEASUREMENTS OF STACKING EFFICIENCY WITH THE CERN ELECTRON STORAGE AND ACCUMULATING RING (CESAR). Jones, E.; Koziol, H.; Magnani, L.; Pentz, M. J. (European Organization for Nuclear Research, Geneva (Switzerland)). Apr. 19, 1967. 16p. Dep.

The efficiency with which the CERN electron storage and accumulation ring (CESAR) can stack many successively injected pulses by means of radio-frequency acceleration is investigated. (B.G.D.)

29657 (CERN/TC/BEBC-66-73) REPORT ON THE DESIGN STUDY OF A LARGE HYDROGEN BUBBLE CHAMBER FOR THE CERN PROTON SYNCHROTRON. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 1966. 144p. Dep.

The physics aspects, construction program, and the budget of a large hydrogen bubble chamber for the CERN proton synchrotron are discussed. (B.G.D.)

29658 (CNEA-188) EL SINCROCICLOTRON DE BUENOS AIRES INFORME RETROSPECTIVO PERIODO 1954-1965. (Data on Buenos Aires Synchrocyclotrons for the Years of 1954-1965). Mayo, Santos (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1966. 34p. (In Spanish). Dep.

Since its opening in 1954 the synchrocyclotron laboratory has offered facilities first for studies in nuclear chemistry, then in nuclear physics, and most recently in nuclear biology. A general description is given of the laboratory. A bibliography is given of the completed nuclear physics, chemistry, and biological problems studied. (J.S.R.)

29659 (DESY-67/7) ABHAENGIGKEIT DER SPEICHER-RING-LUMINOSITAET VON DER TAILLENWEITE UND VOM KREUZUNGSWINKEL. (Dependence of Storage Ring Luminosity on the Region Width and on the Crossing Angle). Piwinski, A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1967. 24p. (In German). Dep.

The storage ring luminosity as limited by the beam-beam space charge interaction is calculated, taking into account the crossing angle, the shape of the amplitude function in a low-β-region and the dependence of the Q-shift on the position of the particle within the bunch. It appears that there is an optimum value β_0 for which the luminosity has a maximum. With increasing crossing angle and given beam size, the Q-shift falls off more rapidly than the luminosity. By adjusting the beam cross section for constant Q-shift, an increase of luminosity with increasing crossing angle is obtained. (auth)

29660 (DESY-67/9) MEASUREMENT OF THE BEAM CURRENT IN THE 6-GeV ELECTRON SYNCHROTRON DESY UTILIZING THE SYNCHROTRON RADIATION. Haensel, R.; Sonntag, B. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Mar. 1967. 7p. Dep.

An optical method, based upon a measurement of the intensity of the synchrotron radiation given off by electrons, for determining the beam current in the 6-GeV electron synchrotron DESY is presented. (B.G.D.)

29661 (DESY-67/12) STRAHLPROFILMESSUNG MIT SILBERPHOSPHATGLAESERN. (Beam Profile Measurements with Silver Phosphate Glasses). Eckardt, V. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1967. 21p. (In German). Dep.

After irradiation with x-ray, γ-ray, or particle beams silver phosphate glasses show photoluminescence when subsequently exposed to ultraviolet light. The intensity of the emitted red light is linearly proportional to the beam intensity over several decades. For measuring beam profiles 8×3 cm plates of 0.2 cm thickness were used. A semi-automatic apparatus for evaluating the intensity distribution in the glass plates is described. Beam profiles were measured over 4 decades of intensity with only a few percent of error. Examples of profiles and iso-intensity curves are presented. The same method was applied to the determination of shower development in lead at 2.84 GeV. The data show good agreement with theoretical predictions. (auth)

29662 (LAL-1170) L'INJECTION DANS L'ANNEAU DE COLLISIONS D'ORSAY. (Injection in the Orsay Collision Rings). Beck, R. A.; Gendreau, G.; Haissinski, J.; Marin, P. C. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Feb. 1967. 11p. (In French). Dep.

The injection system used at the Orsay collision rings is a multirevolution injection system making use of a walled magnetic inflector. The injected particles spiral toward the center of the chamber under the influence of a variable deflecting field furnished by the perturbator placed in the section opposite to the injection section. Experimental data show that nonlinearity and resonances play a primary role in the injection mechanism. The nonlinearity responsible for the dependence of the betatron wave numbers on the energy and the amplitude and the inevitable presence of resonances explain the injection yield measured on the storage ring. (J.S.R.)

29663 (LYCEN-6713) DETERMINATION DE L'ENERGIE ET DE LA STRUCTURE DU FAISCEAU DE PARTICULES ACCELEREES PAR LE SYNCHROCYCLOTRON DE 180 cm DE LA FACULTE DES SCIENCES DE LYON. (Determination of the Energy and Beam Structure of Particles Accelerated by the 180-cm Cyclotron of the University of Lyon). Suraqui, Samy (Lyon Univ. (France). Institut de Physique Nucleaire). Feb. 1967. 125p. (In French). Dep.

Thesis.

Experimental devices were designed for determining the energy of a synchrocyclotron. The first device is a slowing down system and the second a thermoelectric probe. The principles, the development and the experimental results obtained with each are described. With the first device the energy of the accelerator could be determined statistically. It was established that the stability was very good for the operational conditions used, particularly in α. With the second device it was possible to make a tentative determination of the spatial structure of the beam. The possibilities for additional uses of each device are considered. (J.S.R.)

29664 (MPS/DL-Int.-65-1) SOME EXAMPLES OF ENERGY FLOW IN THE ALVAREZ STRUCTURE. Hereward, H. G. (European Organization for Nuclear Research, Geneva (Switzerland)). Jan. 26, 1965. 30p. Dep.

A model of the Alvarez structure, as used to accelerate protons in the 2π mode of the low-β region is presented along with the wave equation for the structure ($dI/dx = -j\omega C_s \cdot V$). The solutions of the second-order equation derived from the above equation are also presented. The model and the equations are used to describe various aspects of energy flow. These are mode spacing, group velocity and energy velocity for traveling waves, and energy transport at zero mode. (B.G.D.)

29665 (NP-16690) PRIBOR DLYA IZMERENIYA PARAMETROV KOGERENTNYKH RADIAL'NO-FAZOVYKH KOLEBANII V NAKOPITELYAKH USTANOVOK SO VSTRECHNYMI PUCHKAMI. (A Device for the Measurement of Coherent Radial-Phase Oscillation Parameters in Colliding Storage Rings). Pirushkin, E. A.; Starodubtseva, T. P. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1965. 12p. (In Russian). Dep.

A method for the measurement of the phase displacement be-

tween the first harmonic of the signal, directed with the beam on the electrostatic electrode, and the voltage on the resonator in the angular range from 0 to 360° with a precision of 0.5° at resolving capacities of 0.1° was described. The method can be used for the measurement of the coherent loss in the VEPP-2 storage ring and during recording of the collision of two brief bursts. (tr-auth)

29666 (ORNL-P-3091) A SECTOR MAGNET FOR A 10-50 MeV SOC. Hudson, E. D.; Lord, R. S.; McDaniel, F. E. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 4p. (CONF-670307-56). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

A full-scale prototype magnet sector of a 12-sector, 10–50 MeV separated orbit cyclotron was built and tested. Eleven pairs of alternating-gradient pole tips are mounted on a yoke structure which provides a common magnetic return path. The pole tips are all excited by a single pair of coils which surround the pole tip mounting bases at the upper and lower yoke faces. The pole tips combine both the negative- and positive-gradient sections in a single unit; the magnetic field gradients are about 800 gauss/in. The pole tips are 4.5 in. wide and have a mean gap of 1.75 in. They were machined by the numeric controlled milling process. Special edge contours were developed to achieve a useful radial aperture of 3 inches. Experience with the prototype magnet demonstrates that magnets for separated orbit cyclotrons present no special difficulty in design, construction, or alignment. (auth)

29667 (ORNL-P-3092) MAGNET SYSTEM FOR A 4-MeV EXPERIMENTAL SEPARATED ORBIT CYCLOTRON. Hudson, E. D.; McDaniel, F. E. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 4p. (CONF-670307-55). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

One of six sector-magnets for the 4-MeV Separated Orbit Cyclotron Experiment (SOCE) was assembled and tested. The magnets for the SOCE are quite different and much simplified from previous SOC magnet concepts; all pole tips are of the same radius of curvature and each set is excited by a separate coil-pair. The pole-tip fields vary smoothly from 3.5 kilogauss at injection (1 MeV) to 6.6 kilogauss at full energy. The field index, n, varies from 0.58 to 0.52. A unique pole-tip design with an integral vacuum chamber has been developed. The ampere-turn requirements for the main pole-tip coils and trimming coils have been determined. A simple but highly precise magnetic field scanning device was developed for use with the SOCE magnets. (auth)

29668 (RHEL/R-141) A STUDY OF THE FEASIBILITY OF TRANSPORTING THE BEAM FROM THE 50 MeV PLA FOR INJECTION INTO NIMROD. Planner, C. W. (Rutherford High Energy Lab., Chilton (England)). Dec. 1966. 35p. Dep. CFSTI. UK 4s. 6d.

From the study described it is concluded that transport of a 50-MeV beam from the Proton Linear Accelerator to Nimrod, with an acceptable beam profile, is technically feasible (both machines being situated in their present positions). The resulting increase in injection energy, from 15 MeV to 50 MeV, should increase the space charge limitation of the synchrotron by a factor of 3. Since the first bending magnet of the proposed transport system is of small angle, it should be possible to pulse this magnet and thus allow 50 MeV beams to be switched between Nimrod and the PLA experimental area. Overhead and underground beam transport systems are considered. A cost estimate is given and compared with that for rehousing and rebuilding the PLA adjacent to the present 15 MeV injector. (UK)

29669 (RHEL/R-142) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, September 20–December 31, 1966. Gray, D. E. (Rutherford High Energy Lab., Chilton (England)). Feb. 1967. 12p. Dep. CFSTI. UK 3s. 0d.

Details are given of the operation of Nimrod over the period. Machine development included installation of a beam servo system for damping coherent vertical beam oscillations in the $(1 - Q)$ mode. The quality of flat-top spill was materially improved by the introduction of a noise servo spill system, and by a method of reducing rf structure. Equipment has been commissioned to reduce the 2nd harmonic ripple on the magnet waveform. The experimental program is outlined. (UK)

29670 (RLO-1388-22) TERMINAL VOLTAGE FLUCTUATIONS OF AN FN TANDEM VAN DE GRAAFF ACCELERATOR. Fauska, H.; Heagney, J. S.; Morgan, T. J.; Schmidt, F. H. (Washington Univ., Seattle). [1966]. Contract AT(45-1)-1388. 8p. (CONF-670307-54). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

The terminal potential of an FN tandem Van de Graaff accelerator fluctuates by 500 to 1000 volts. The repetitive character of the fluctuates indicates that the cause lies in inhomogeneities of the belt. Evidence is presented indicating that the inhomogeneities probably arise from the manner in which the rubber-impregnating compound on the belt is cured. A simple method for reducing the effects of these inhomogeneities is suggested. (B.G.D.)

29671 (SJC-A-66-1) THEORY OF THE RESONANT BEAM EJECTION FROM AG SYNCHROTRON. Kobayashi, Y. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Aug. 1966. 50p. Dep.

An analytical treatment of the resonant beam extraction from AG synchrotrons based on an approximate Hamiltonian and its application to integral, half-integral, and third resonance extractions is presented. (B.G.D.)

29672 (SLAC-PUB-274) SUPERCONDUCTING MAGNETS FOR HIGH ENERGY PHYSICS APPLICATIONS. Brechna, H. (Stanford Linear Accelerator Center, Calif.). Feb. 1967. Contract AT(04-3)-515. 44p. (CONF-670409-3). Dep. CFSTI.

From International Cryogenic Engineering Conference, Kyoto, Japan.

With the availability of high energy accelerators the need for powerful experimental, beam transport and special magnets is steadily increasing. Experimental high field large volume water-cooled or conventional magnets would have power requirements which would be economically unsound. Superconducting magnets have reached a stage where they can be incorporated in connection with high energy physics, and many laboratories are building experimental magnets to be used for charged particle energies between 10 and 20 GeV. Recent developments in hard superconductors, technological improvements and a better understanding of steady state stable behavior of superconducting magnets enables us to build multimegajoule energy magnets with fields approaching 100 kG in working values of several cubic meters. Recent trends in superconducting magnet design are discussed. A number of large superconducting magnets currently in operation are described as well as magnets in stages of procurement and planning. The use of ferromagnetic materials with superconducting magnets, the effects of superfluid and supercritical helium in magnet performance and forced liquid helium cooling are also treated. (auth)

29673 (SLAC-PUB-313) DETERMINATION OF THE QUALITY OF MULTIPOLE MAGNETS. Cobb, J. K.; Burfine, A. W.; Jensen, D. R. (Stanford Linear Accelerator Center, Calif.). June 1967. Contract AT(04-3)-515. 10p. (CONF-670705-4). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

A large number of multipole magnets were analyzed and methods of final representation were developed that give in functional form $\int_{-\infty}^{+\infty}(\delta BdZ/B) = f(r,\theta)$ and $\int_{-\infty}^{+\infty}(\delta GdZ/G_0) = g(r,\theta)$ for the elements where $\delta B = B - G_0 r$ and G_0 is the gradient at the center. A computer program was written which uses as input data the directly read harmonic amplitudes at many discrete longitudinal positions and then computes the total integrated perturbation at various positions across the aperture. (B.G.D.)

29674 (UCRL-17141) RADIATION PROBLEMS WITH HIGH-ENERGY PROTON ACCELERATORS. Gilbert, William S. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 21, 1967. Contract W-7405-eng-48. 18p. (CONF-670307-53). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

A discussion is presented on proton accelerators in the multi-GeV energy range and of the alternating-gradient synchrotron type, with special attention given to the existing 30-GeV and the proposed 200- to 300-GeV machines. Radiation problems can be divided into two broad groups: those produced by the accelerator while it is running and those associated with the shut-down machine. The expense and difficulty of coping with these radiation problems influence the choice of design beam intensity. The problems while the machine is running are penetration of radiation through the shielding, muon shielding, penetration of radiation through ducts and labyrinths, skyshine, diffusion of radioactive air, and radiation damage to components. Some results of an LRL-CERN-Rutherford shielding experiment on the CERN-PS are presented. Problems of the shut-down accelerator include induced activity in the machine components and enclosure walls. These radiation fields affect maintenance procedures and require appropriate handling tools and shielded vehicles. (auth)

29675 (UCRL-17191) SELECTION OF INJECTOR SYNCHROTRON PARAMETERS TO MINIMIZE COST OF THE 200-GeV ACCELERATOR. Selph, F. B.; Peterson, J. M. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 17,

1967. Contract W-7405-eng-48. 12p. (CONF-670307-52). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

In choosing the type of injector system and in optimizing the parameters of any given type of system, the relative cost advantages as well as relative technical advantages eventually entering into the arguments are considered. A method of determining the cost of accelerator systems is discussed and some examples that arose in the selection of an injector system for the proposed 200-GeV accelerator are given. The cost of the injector system cannot be considered apart from the total accelerator cost because the aperture of the main ring depends upon the energy and emittance of the beam transferred from the injector. Since the main ring is relatively much larger and more expensive than the injector system, a change which lowers injector cost can cause a much larger increase in main ring cost. (auth)

29676 (UCRL-17262) COPPER-TAPE-WOUND, EDGE-COOLED SOLENOID. Morris, Donald W.; Tanabe, Jack T.; Zajec, Emery (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 30, 1967. Contract W-7405-eng-48. 10p. (CONF-670307-51). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

Construction details and tests of a 10-cm-ID and 26.35-cm-long copper-tape-wound solenoid are described. Magnet measurements at 35 kW indicate an axial-field line integral of 193 kG-cm and a transverse-field line integral, measured on the geometric axis, of less than 0.1% of the axial-field integral. (auth)

29677 (UCRL-17278) TARGETRY USED ON THE BEVATRON TO EXTRACT SECONDARY EXPERIMENTAL BEAMS. Stone, Kenneth F. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 10, 1966. Contract W-7405-eng-48. 13p. (CONF-670307-47). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

The development of target drive mechanisms at the Bevatron, with the final evolution of the present high-speed mechanism are discussed. The early target drives, used in the main circulating beam channel, could raise a 1-lb target head 5-½ in. in 100 ms. The present high-speed target drive is designed to raise a ½-lb target head 1-½ in. in 10 ms. The higher-speed mechanism became desirable with increased beam control, allowing for flat topping and splitting individual Bevatron beam pulses between two or more experimenters. All designs are intended for performance in the high vacuum of the accelerating chamber. (auth)

29678 (UCRL-17295) NEW ACCELERATORS FOR VERY HEAVY IONS: PRODUCTION OF SUPER-ELEMENTS. Ghiorso, Albert (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 15p. (CONF-670307-49). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

A general picture is presented on the production of the super elements Z > 101 and the requirements imposed on accelerators designed to further this research. (B.G.D.)

29679 (UCRL-17296) SOME RECENT DEVELOPMENTS IN VACUUM TECHNIQUES FOR ACCELERATORS AND STORAGE RINGS. Milleron, Norman (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 23p. (CONF-670307-50). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

A review of ultrahigh vacuum problems peculiar to accelerators and storage rings is presented. Topics discussed are vacuum pumps, beam interactions with gases, pumpdown results, repairing of leaks during pump tests, recovery from accidents and malfunctions, weld and cut joints, and alumina beam tube. (B.G.D.)

29680 (UCRL-17372) BROADBAND MODULATION OF HIGH-Q RESONATORS AT HIGH POWER LEVELS. MacKenzie, Kenneth R. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 23, 1967. Contract W-7405-eng-48. 45p. Dep. CFSTI.

Electronic broadband frequency modulation of a high-Q resonator operating at high voltages is considered. The simple overcoupled transformer is shown to be the most practical way to couple the final amplifier tubes to the resonator. Capacities other than the resonator capacity and the inherent tube capacity should be minimized. Transmission lines should be high-impedance and as short as possible. The maximum frequency range is shown to be governed by $V_1\Delta\omega = 1.4\ \gamma g$, where V_1 is the resonator voltage, $\gamma = V_1/V_2$ (where V_2 is the tube rf voltage), and $g = I_e$ is the tube filament emission and C_2 is the tube capacity. This relation reduces to $V_2\ \Delta\omega = 1.4\ g$, showing that $\Delta\omega$ is limited only by tube parameters and not by resonator capacity or voltage. The minimum average power using a programmed dc plate voltage is shown to be $0.2\ V_1^2\ C_1\ \Delta\omega$ (where C_1 is the resonator capacity). Modulation rates, higher-order modes, transmission-line corrections, and other coupling schemes are discussed. (auth)

29681 (AD-645794, pp 47-57) LENSES FOR THE COMPENSATION OF THE EFFECT OF INTERSECTIONAL GAPS IN LINEAR PROTON ACCELERATORS. Vlasov, A. D. Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1959.

The compensation of the unfavorable effect of intersectional gaps in linear proton accelerators with sign-alternating focusing on the radial oscillations of particles is considered. This compensating effect is proposed to be achieved with special quadrupole magnetic lenses of two types: the so-called unit and elongated lenses. (auth)

29682 (AD-645794, pp 65-83) CERTAIN IONIC-OPTICAL PROPERTIES OF STATIC AXIAL-SYMMETRIC MAGNETIC AND ELECTRICAL FIELDS. Malov, A. F. Translated from Nekot. Vop. Eksp. Fiz., No. 2, 1959.

Nonlinear research has been conducted on the properties of crossed electrical and magnetic fields of sectional axisymmetric type with asymmetric focusing and having edges of arbitrary form The results of this research are partially discussed. Derivations of fundamental equations of beam motion in the central plane are presented. These equations are then used in the calculation of trajectories and classes of focusing fields omitting the influence of edge effects. The basic method of research which is used is presented. (auth)

29683 ON THE PRODUCTION OF MULTICHARGED IONS OF CARBON, NITROGEN, AND OXYGEN BY THE HEAVY ION SOURCE FOR CYCLOTRON. Kono, Isao; Tonuma, Tadao (Inst. of Physics and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 42: No. 3, 68-75(May 1966). (In Japanese).

In a 160 cm cyclotron multi-charged ions of carbon, nitrogen and oxygen can be accelerated. Therefore, it was tried to produce the multi-charged ions such as C^{3+}, N^{3+}, O^{3+}, N^{4+} from an indirect hot cathode-type ion source. The construction of this ion source and the working conditions for production of the multi-charged ions were investigated. It was shown that a high-temperature arc plasma could be formed successfully by eliminating the thermal radiation from the indirect hot cathode using a thermal radiation shield of graphite. The ion beams extracted from the ion source were analyzed with a magnetic analyzer and the rates of production of various multi-charged ions were measured. It was found that C^{3+}, N^{3+} and O^{3+} ions were obtained at over 13% while N^{4+} ion at 2%. The dependence of the production rates of N^+, N^{2+} and N^{3+} on the arc current and voltage was also investigated. (NSA of Japan)

29684 SIMPLIFICATION OF THE PROCEDURE OF CALCULATING OF THE TRAJECTORY ENVELOPE IN THE PARTICLE ACCELERATORS. Lembra, Yu. Ya. (Tartu State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 65-9(1966). (In Russian).

A simplified method for calculating the trajectory envelope in an accelerator using the matrix method for finding the square of the Floquet function for the betatron oscillation equation which enabled finding the real magnitude without complex computations. The method was used for calculations in the case of a racetrack of a strong-focusing accelerator and regenerative deflector. (tr-auth)

29685 PRODUCTION AND ACCELERATION OF ION BEAMS IN THE TANDEM ACCELERATOR. Rose, P. H.; Galejs, A. (High Voltage Engineering Corp., Burlington, Mass.). pp 1-116 of Progress in Nuclear Techniques and Instrumentation. Vol. 2. Farley, F. J. M. (ed.). New York, John Wiley and Sons, Inc., 1967.

A brief historical note, definition of the types of tandem accelerators, and a description of the tandem accelerator are given in the introduction. The basic processes which bring about the formation of positive, neutral and negative charge states of atomic beams are then discussed, which include electron capture, electron stripping at high energies, and energy loss and scattering in charge-changing targets. The principles of ion beam formation are treated, and examples are given of collisional negative ion sources, direct extraction negative ion sources, and neutral ion sources. Invariance theorems, linear theory, and exact calculations and aberrations are discussed in the next section. Finally, injection and acceleration of ion beams are treated, with discussions on the injector and one-stage tandem, injection modes of the two-stage tandem, three-stage tandem accelerators, transmission and acceleration, and post-acceleration beam handling. 156 references. (L.B.S.)

29686 PARTICLE SEPARATION AT HIGH ENERGIES. I. ELECTROSTATIC SEPARATION. Neale, W. W. (Imperial Coll. of Science and Tech., London). pp 117-60 of Progress in Nuclear Techniques and Instrumentation. Vol. 2. Farley, F. J. M. (ed.). New York, John Wiley and Sons, Inc., 1967.

A review is given of achievements and future developments using the technique of electrostatic separation for beams suitable for use with bubble chambers and other non-triggerable devices. The dynamics of charged particles inside electrostatic separators and the theory of electrostatic separation are discussed. The various problems encountered by the designer of electrostatically separated beams are dealt with in some detail. The problems encountered in the tuning of electrostatically separated beams are then discussed. Finally the limitations of the technique of electrostatic separations are considered, and comparison is made with other techniques of separation. (L.B,S.)

29687 NEW BRITISH ELECTRON ACCELERATOR. Nature, 214: 1183-5(June 17, 1967).

A description is given of the 4 GeV electron accelerator, NINA, recently commissioned at the Daresbury Nuclear Physics Laboratory (Science Research Council), U.K. It has been found possible to accelerate particles to 4.5 GeV, and modifications of the beam injection system may make 5 GeV possible. The accelerator is of the strong-focusing synchrotron type, and has 40 magnet units, each 3.3 m long, arranged around the axis of the 70.2 m diameter circular track. The magnet units are of two types, arranged for focusing and then defocusing the electron beam in the horizontal plane of its path around the machine. NINA differs from its contemporaries in that the two types of magnet units alternate all around the machine. The injection system is a 40 MeV linear accelerator, and injection takes place in a single turn, occupying 0.75 μ sec. Arrangements have been made to accelerate positrons The machine has already produced >1 μa. It produces 50 pulses of fast electrons per second. The rf system is designed to handle 1.2×10^{12} electrons per pulse, and it is hoped that the mean current may eventually reach 10 μa. Programmes of experimental work are outlined. (UK)

29688 RUSSIAN ELECTRON ACCELERATOR. Osman, W. A. Nature, 214: 1185-6(June 17, 1967).

A description is given of the 6-GeV electron accelerator at Yerevan, Armenia, due for completion in August 1967. This is one of two high energy accelerators nearing completion in the Soviet Union. It is comparable in size with NINA (Daresbury) in the U.K. and with other accelerators in Cambridge, Mass., and in Germany. The steel vacuum tube is 42 mm high and 120 mm wide and is in the form of a 70 m diameter ring, with 2μ maximum ellipticality, and is split to reduce eddy currents. There are 24 cavities in which the electrons are accelerated from their original energy of 50 MeV, as they emerge from the Linac. The electron beam is constrained by 48 magnets, arranged so that the beam is first focused and then defocused. The magnets are cooled by deionized water. The vacuum pumps are capable of reducing the pressure to 10^{-8} or 10^{-9} mm mercury. The pressure in the cavities is reduced to 2×10^{-6} mm mercury. The energy for acceleration is produced by two transmitters in series, each producing 260 kW per pulse, 100 pulses per sec. The cost is about 15 million rubles. A programme of studies is briefly outlined. (UK)

29689 A 3 MeV ELECTRON ACCELERATOR USING A PRESSURIZED CASCADE GENERATOR. Suematsu, S. (Hitachi Ltd., Japan); Suganomata, S.; Oshima, Y. Nucl. Instrum. Methods, 52: 206-12(1967).

A 3 MV, 6mA cascade generator to accelerate electron beams for irradiation was constructed and tested. The cascade generator circuit is of the symmetrical inverse type using selenium rectifiers operating at a frequency of 10 kc/s. The voltage drop and the capacitive input impedance of the generator due to stray capacitance are compensated by the compensation coils inserted into the circuit at intervals of 5-stages. The 120-stages accelerating tube is made of overlapped μ-metal electrodes for shielding the external field. Special care was devoted to the protection against the puncture of the scanner window and the surge of the generator. Construction and performance of the accelerator are described. The accelerator is satisfactorily used for irradiation purposes. (auth)

29690 BETATRON OSCILLATION RESONANCES IN AN ELECTRON SYNCHROTRON. Artemeva, S. L.; Kulikov, O. F.; Metalnikov, Yu. N.; Moroz, E. M.; Petukhov, V. A.; Shorin, K. N. (Lebedev Inst. of Physics, Moscow). Nucl. Instrum. Methods, 52: 325-30(1967).

The conditions under which certain betatron resonances of the 2nd to the 5th order are excited, and their influence on accelerator operation, were studied in an electron racetrack. The precise measuring methods (≈0.1%) of parameters n and λ which determine the betatron oscillation frequencies and resonance relations, are elaborated. High speed filming of optical synchrotron radiation was broadly used in experimental investigations. (auth)

29691 SUPERCONDUCTING PROTON SYNCHROTRONS. Smith, P. F.; Lewin, J. D. (Rutherford Lab., Chilton, Eng.). Nucl. Instrum. Methods, 52: 298-308(1967).

The results of a preliminary study of the possibility of using pulsed high field superconducting magnets in place of the conventional iron-core magnets in high energy proton synchrotrons are summarized. Cost estimates are compared for alternating gradient synchrotrons using conventional, cryogenic, or superconducting magnets. The latter offer, in principle, the possibility of substantial reductions in size and cost; for example, a superconducting 1000 GeV accelerator operating at a field of 60 kG might be built at a cost no greater than that of a conventional 300 GeV machine. Inexpensive conversion of existing accelerators to higher energy might also be possible. Estimates are made of the heat dissipated in the magnet by ac losses, eddy currents, and high energy particles. Reduction of the ac loss to a tolerable level necessitates subdivision of the superconductor into insulated strands no greater than about 5 μm in dia. Although this requires a substantial advance in superconductor technology, several possibilities for producing such a conductor can be envisaged and are being investigated. A number of other aspects of the magnet and accelerator design are surveyed briefly. (auth)

29692 NEW EXTRACTION SYSTEM FOR A SYNCHROTRON BY A PULSED MAGNET AND AN ENERGY-LOSS TARGET. Suwa, S.; Yokosawa, A. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 52: 277-83(1967).

The use of a pulsed magnet and an energy-loss target was developed as an extraction device for a weak-focusing proton synchrotron. The device is suitable for producing beam pulses of down to 10 μsec with high efficiency. Numerical calculations were made to find the optimum arrangement for the Argonne Zero Gradient Synchrotron. This device has been constructed and tested, and the results confirmed the high-efficiency extraction. (auth)

29693 SECOND ORDER TRANSFER MATRICES OF REAL MAGNETIC AND ELECTROSTATIC SECTOR FIELDS. Wollnik, H. (Justus Liebig Univ., Giessen, Ger.). Nucl. Instrum. Methods, 52: 250-72(1967).

With the help of second order transfer matrices it is easily possible to calculate focusing and dispersion properties as well as second order image aberrations of any ion optical apparatus consisting of one or of several sector fields. Taking into account, in addition to the deflections in the main fields, all effects of the fringing fields, such transfer matrices are presented here for magnetic and electrostatic sector fields which have circular main paths in the main deflecting fields. (auth)

29694 ELECTROSTATIC INSTABILITIES IN CHARGED SHEETS. Enriques, L.; Iannuzzi, M. (EURATOM-CNEN, Frascati, Italy). Nuovo Cim. (10), 49B: 196-8(June 11, 1967).

A continuous model for a beam of charged particles which flows between metallic walls is analyzed. The beam is considered as a flexible charged sheet which is maintained in an equilibrium position by an elastic force. The stability of this equilibrium is studied for small perturbations with the wave vector perpendicular to the direction of the sheet motion. Above a critical charge density the beam is found to be unstable even in the case of zero wall resistivity. (J.F.P.)

29695 MEDICAL LINEAR ACCELERATOR NELAC-1006. Ouchi, Atsuyoshi; Otani, Shiro (Nippon Electric Co., Ltd., Japan). NEC (Nippon Elec. Co.) Res. Dev., No. 77, 11-23(June 1966). (In Japanese).

The NELAC-1006 was completed in September 1965 as the first medical linear accelerator to be manufactured in Japan. The accelerator, designed by NEC, employs a multistage collimator at its head and is equipped with an automatic control for lesion irradiation. The main features are as follows. x-rays: maximum dosage over 350 rads/min.; irradiation-field uniformity less than 3%; radiation-source focus diameter below 3 mm; leaking radiation field less than 0.1%; and dosage stability during the rotation below ±3%. Electron-rays: energy range 4 to 7 MeV; and irradiation field uniformity below ±15%. Rotations: gantry rotation-range 360°; gantry rotation-speed maximum 360°/min. and minimum 36°/min.; x-ray head rotation range 360°; and isocenter movement-error—gantry rotation below ±1 mm and x-ray head rotation below ±1 mm. The range of variation in the irradiation field: up to 27×30 cm^2. (NSA of Japan)

29696 NEC 6 MeV MEDICAL LINEAR ACCELERATOR. Kitabatake, Takashi (Aichi Cancer Center, Japan); Takahashi, Shinji. Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1267-76 (Jan. 1967). (In Japanese).

An outline of performance tests of NEC 6 MeV medical linear accelerator installed in the Aichi Cancer Center was described. The energy of the electron beam was continuously changed from 4 to 7 MeV, although x-ray beams were most stable near 6 MeV. At 6 MeV, the maximum output of equalized x-rays was about 350 R/min at a point of 1 m from the target. The fluctuation of

x-ray output was under ±1%. The dose variability in rotation radiotherapy was ±1.54%. X-ray beams were most homogeneously distributed spacially at the depth of 10 cm in water. The size of the x-ray target was estimated to be 2.64 mm × 2.32 mm. Isodose charts and depth dose curves of 6-MeV x-rays were made in various field sizes. On the other hand, the maximum aberration of the isocenter was estimated to be under 0.5 mm. The speed of rotation was fluctuated with a variance of ±1.7%. The ranges of error of a conformation radiotherapy mechanism were distributed within +1.47% to −1.80%. Also leakage dose, scattered radiation dose near the radiation field, and scattering radiations in a treatment room were measured. (auth)

29697 THE VAN DE GRAAFF GENERATOR OF THE CENTRAL PHYSICAL RESEARCH INSTITUTE. Ero, Janos (Central Physical Research Inst., Budapest). Fiz. Szemle, 17: 7-14(Jan. 1967). (In Hungarian).

In view of the great importance of the pressurized electrostatic Van de Graaff generators for nuclear research, design work was started in 1952 at the Central Physical Research Institute for the development of such a machine. By 1954 the potential source was completed. The generator operated at a maximum voltage of 4.5 MV under a pressure of 17 atm., using a nitrogen–carbon dioxide mixture with a few percent of freon, with a short-circuit current of 430 μamp. Technical and financial problems delayed the construction of the accelerator tube until 1963. Ion-beam energies up to 2.5 MeV were obtained but problems arose beyond about 2 MeV. In its current state, the machine makes it possible to direct the beam at any of three experimental locations by means of a distributing magnet. The accelerator and control room are located at the upper level of the building, while the target area, the analyzing and distributing magnets, the experimental rooms and the compressor room are located below. The experiments carried out by means of this machine are summarized. (TTT)

29698 PROOF OF THE IMPOSSIBILITY OF DESIGNING A CYLINDRICAL ELECTROSTATIC DIVERGING LENS. Glikman, L. G.; Kel'man, V. M.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 37: 13-16(Jan. 1967). (In Russian).

A proof is given of a well-known theorem that a cylindrical electrostatic diverging lens cannot exist, which, unlike the proof given by J. R. Pierce in his monograph on electron beams, is valid for relativistic particle velocities and is not limited to paraxial trajectories. The proof is given only for meridional trajectories, but it is asserted that the proof can be easily extended to include oblique trajectories. (ATD)

29699 HELIUM ION BEAM WITH 200 A CURRENT AND 70 keV ENERGY. Pleshivtsev, N. V.; Martynov, V. I.; Tomashev, G. G.; Grigorovich, Yu. F.; Shembel, B. K. At. Energ. (USSR), 22: 128-31(Feb. 1967). (In Russian).

The results of tests made on the development of an intense beam of helium ions in continuous regime were reported. The design of the experimental device is given. The parameters of the ion source focussing system, and helium ion beam are tabulated. (J.S.R.)

29700 ELECTRON–MAGNON SCATTERING AND POLARIZATION OF THE SCATTERED BEAM. DeWames, R. E.; Vredevoe, L. A. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev. Lett., 18: 853-5(May 15, 1967).

The use of electron-magnon scattering as a probe of the magnon spectrum and as a means of producing polarized electron beams is discussed. (auth)

29701 THE SYNCHROTRON RADIATION OF THE 6-GeV DESY MACHINE AS A FUNDAMENTAL RADIOMETRIC STANDARD. Lemke, D.; Labs, D. (Landessternwarte Heidelberg-Koenigstuhl, Heidelberg). Appl. Opt., 6: 1043-8(June 1967).

The characteristics of synchrotron radiation emitted by the 6-GeV DESY machine were studied in the spectral range 2200–5500 Å. For this purpose, the synchrotron radiation was compared photoelectrically with the radiation of standardized sources in a nearly differential manner. These sources (tungsten ribbon lamp, Krefft–Rössler uv normal) were calibrated with high accuracy against a blackbody. Good agreement was found between our experimental results and the values predicted by the theory of the synchrotron radiation derived by J. Schwinger. The relative spectral distribution was verified to within about ±2%, and the absolute values of the theoretically predicted flux were ascertained to within about ±15%. For the application of synchrotron radiation as a radiometric standard, in most cases only the relative spectral distribution is important. If one supposes the validity of the theory also in the far uv, and if the synchrotron radiation is calibrated in the visible by a standard source, one can give the absolute flux in the far uv. In this way it is possible to calibrate photometers or sources in the far uv in absolute units with an accuracy of about ±3% with the aid of the synchrotron radiation. (auth)

29702 TIME VARIATION OF THE EQUILIBRIUM ORBIT RADIUS IN A BETATRON. Haltrich, St.; Panaitescu, I. (Inst. for Atomic Physics, Bucharest). Bul. Inst. Politeh. Bucuresti, 28: No. 3, 29-37(May-June 1966).

The variation in time of the equilibrium orbit position is one of the main factors that may limit the maximum energy of the electrons accelerated in a betatron. A graphical and analytical calculation method was worked out allowing a relatively simple and quite accurate determination of the variation of the equilibrium orbit radius and of the variation of the equilibrium orbit which takes place because of the magnetic core saturation. Experimental tests carried out on the betatron at the Institute of Atomic Physics of the Academy of the Rumanian Socialist Republic gave results corresponding to the values calculated by the new method. (auth)

29703 ION SOURCE. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1966-10555. May 18, 1966. Filed Feb. 17, 1964.

In the hot cathode-type ion source proposed, the efficiency of arc current is increased. The ion source includes a filament, an anode, an electrode between the filament and anode, an arc power-source connected between the filament and the anode, etc. Between the middle electrode and the anode is connected a pair of resistors, one with a low resistance and the other with a high resistance; in the source operation, the low one, then the high one, is connected by means of a switch in the same circuit. The switch is operated by means of a relay installed in the circuit of the arc power-source. (NSA of Japan)

29704 ION GENERATOR. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1966-10554. May 18, 1966. Filed Feb. 17, 1964.

An ion generator for use in a plasmatron is proposed in which the ion source includes a filament, an anode, an electrode placed between the filament and anode, an arc power-source connected between the filament and the anode, etc. The coil for producing the magnetic field to contain the arc is placed in the circuit of the arc-power source. (NSA of Japan)

29705 V INTERNATIONAL CONFERENCE ON HIGH ENERGY ACCELERATORS, FRASCATI, SEPTEMBER 9–16, 1965. Grilli, Mario (ed.). Rome, Comitato Nazionale per l'Energia Nucleare, 1966. 766p. $18.00. (CONF-650923).

Separate abstracts are prepared for 112 of the 145 papers presented. Thirty-three were previously included in NSA. For abtract numbers of these papers see CONF-650923 in the Report Number Index. (B.G.D.)

For abstracts of individual papers see: 28272, 28328, 28329, 29427, 29448, 29460, 29461, 29706–29809, and 30079.

29706 REPORT ON THE CERN 300 GeV STUDY. Johnsen, K. (CERN, Geneva). pp 3-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Activities of the special Study Group for New Accelerator Projects at CERN as to the development of a 300-GeV proton synchrotron are reported. Activities discussed were general layout of experimental areas, site studies, and time schedule and cost. A brief description of the synchrotron is given along with a summary of the expected performance. (B.G.D.)

29707 METHODS OF AUTOMATIC ORBIT CORRECTION IN RING ACCELERATORS. Burshtein, E. L.; Vasil'ev, A. A.; Dzergach, A. I. (Radiotechnical Inst., Moscow). pp 34-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Several methods for automatic orbit correction in very high-energy (several hundred GeV) ring accelerators are presented. The methods are based on bunch position data. (B.G.D.)

29708 WIDE BAND TRAVELING WAVE ACCELERATING METHOD FOR A 300 GeV PROTON SYNCHROTRON. Schnell, W. (CERN, Geneva). pp 38-41 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A wide band travelling wave accelerating structure, which requires substantially less power than comparable structures made of resonant cavities, is described for use in the 300-GeV proton synchrotron. (B.G.D.)

29709 CASCADE SYNCHROTRONS FOR ENERGIES UP TO 100 GeV. Kitagaki, T.; Ishii, C.; Masuda, M. (Tohoku Univ., Tokyo). pp 41-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The technological and economical aspects of cascade synchrotrons for energies up to 100 GeV are discussed. An analysis on the design of a cascade synchrotron along with a cost estimate was made. (B.G.D.)

29710 EXPERIMENTATION WITH PROTON STORAGE RINGS. Hyams, B. D. (CERN, Geneva). pp 47-50 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A discussion is presented on how the applications of the CERN storage rings influence their design. A review of the design parameters is presented. (B.G.D.)

29711 CPS IMPROVEMENT PROGRAMME. Standley, P. H. (CERN, Geneva). pp 80-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The possibility of increasing the CPS intensity and extending the experimental areas is discussed. (B.G.D.)

29712 STATUS REPORT OF THE ITEP PROTON-SYNCHROTRON OPERATION. Goldin, L. L.; Onosovskii, K. K.; Kuryshev, V. S.; (and others) (Inst. for Theoretical and Experimental Physics, Moscow). pp 85-91 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A status report is presented on the ITEP proton synchrotron operation. Topics include magnetic Hall shielding, power supply, resonance due to quadratic nonlinear fluctuations, forged vertical oscillations (half-integer resonance), particle losses due to Coulomb interaction, betatron oscillation frequencies, high-frequency system, and beam dimensions (particle separator). (B.G.D.)

29713 ITEP PROTON SYNCHROTRON INJECTOR. Lapitskii, Yu. Ya.; Khoroshkov, V. S.; Onosovskii, K. K. (Inst. for Theoretical and Experimental Physics, Moscow). pp 92-6 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Several improvements to the ITEP proton synchrotron injector are discussed. They were introduced in order to raise the intensity of the beam and to shorten maintenance and the time of high voltage training. Particular components discussed are the ion source, focusing system, and pumping system. (B.G.D.)

29714 ELIMINATION OF BETATRON OSCILLATIONS COUPLING IN THE ITEP PROTON SYNCHROTRON. Goldin, L. L.; Zenkevitch, P. R.; Talyzin, A. N. (Inst. of Theoretical and Experimental Physics, Moscow). pp 97-100 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The use of oscillations coupling compensation coils for eliminating betatron oscillations coupling in the ITEP proton synchrotron is discussed. (B.G.D.)

29715 SOME FEATURES OF GRADIENT CORRECTION IN THE ITEP PROTON SYNCHROTRON. Veselov, M. I.; Zenkevitch, P. R. (Inst. for Theoretical and Experimental Physics, Moscow). pp 101-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The ITEP proton synchrotron focusing system (L – 1) has magnetic blocks of three types: radially focusing, radially defocusing, and radially focusing quadrupole lenses. Due to the difference between the magnetic blocks the gradient in the accelerator blocks at the moment of injection is not equal to its design value. Three correcting coil systems designed to correct the gradient are described. (B.G.D.)

29716 ZGS PERFORMANCE AND IMPROVEMENT PROGRAM. Teng, L. C. (Argonne National Lab., Ill.). pp 104-11 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The operation and modifications to the ZGS for the past two years are discussed. Topics include the vacuum system, 50 MeV linear accelerator, 750 kV Cockcroft–Walton preaccelerator, beam behavior, magnets, and experiments. (B.G.D.)

29717 NIMROD: PRESENT PERFORMANCE AND PROPOSED DEVELOPMENT. Hobbis, L. C. W. (Rutherford High Energy Lab., Chilton, Eng.). pp 112-17 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The modifications to NIMROD in order to increase beam intensity to 10^{13} ppp are discussed. Topics include injection at higher energies, induced activity, radiation damage and dosimetry, and experimental areas. (B.G.D.)

29718 HIGH-EFFICIENCY TRAPPING BY AMPLITUDE MODULATION OF R.F. VOLTAGE. Batskikh, G. I. (Radiotechnical Inst., Moscow). pp 134-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The method of bunching under the effect of the rf tension with equilibrium phase equal to zero and the frequency equal to (or multiple with) beam rotation frequency is discussed. (B.G.D.)

29719 EFFECT OF NON-LINEARITY OF THE BEAM TRANSPORT SYSTEM ON THE INJECTION PROCESS OF THE PROTON SYNCHROTRON. Sosenskii, N. L. (Radiotechnical Inst., Moscow). pp 138-40 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The relation between the amplitude increment for betatron oscillations of particles injected in proton synchrotrons and magnetic field errors of quadrupole lenses is discussed. The ratio determining the particle loss at injection due to nonlinearity of the beam transport system was obtained. (B.G.D.)

29720 NEW INJECTOR FOR THE SATURNE SYNCHROTRON. Faure, J.; Gouttefangeas, M.; Levy-Mandel, R.; Prome, M.; Rastoix, N.; Rommel, G.; Vienet, R. (CEN, Saclay, France). pp 143-6 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The main characteristics of the future preinjector (750 kV Cockcroft Walton generator) and 20 MeV linear accelerator for the Saturne proton synchrotron are described. (B.G.D.)

29721 ION SOURCE WITH A LARGE BRIGHTNESS. Delbarre, A.; Faure, J.; Vienet, R. (CEN, Saclay, France). pp 147-50 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

An ion source with a large brightness and its focusing system are described. A study to get a 100 mA proton beam pulsed for 600 μsec and having a normalized emittance smaller than 1.2×10^{-6} m is discussed. (B.G.D.)

29722 SLOW CYCLING INJECTION METHOD FOR INTENSITY IMPROVEMENT OF THE CERN-PS (TWIN ACCELERATOR RING TRANSFER SCHEME). Hardt, W. (CERN, Geneva). pp 151-3 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The twin accelerator ring transfer (TART) scheme is described for high-energy slow cycling injection into CERN Proton Synchrotron. The scheme consists of using the present CERN-PS 50 MeV linear accelerator as a pre-injector into an intermediate synchrotron in which the protons are accelerated up to a suitable energy and transferred into the CERN-PS. (B.G.D.)

29723 ARGONNE ZGS MONITOR AND CONTROL COMPUTER SYSTEM. Lewis, L. G.; Knott, M. J.; De Luca, W. H. (Argonne National Lab., Ill.). pp 154-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The method by which data are taken and transferred to the computer at selected times in the ZGS accelerating cycle by the monitor and control computer system is described. The times are determined with respect to the Programmer clocks. (B.G.D.)

29724 BOOTSTRAP METHOD FOR 500 MeV INJECTION INTO THE ALTERNATING GRADIENT SYNCHROTRON. Maschke, A. W.; Danby, G. T.; Forsyth, E. B.; (and others) (Brookhaven National Lab., Upton, N. Y.). pp 157-64 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The bootstrap method for 500 MeV injection into the AGS is discussed. Topics include beam stacking; sawtooth control for magnets; ejection from AGS into the stacking ring; inflection into the stacking ring; ejection from the stacking ring; inflection into AGS; AGS stacking ring beam transport; stacking ring magnets; AGS rf system; stacking ring rf and electronics; stacking ring controls; vacuum systems; and tunnels, buildings, shieldings, utilities and site work. (B.G.D.)

29725 HIGH MAGNETIC FIELD LIMIT IN SYNCHROTRONS. Dahl, P. F.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). pp 165-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The high magnetic field limit at the Brookhaven AGS is explored. The SIBYL computer program was used to compute the magnetic field shapes for the magnets at field levels of 13, 14, and 15 kilogauss. The orbits at these field levels were then investigated with the PARMESH program. (B.G.D.)

29726 CERN INTERSECTING STORAGE RING PROJECT. Johnsen, K. (CERN, Geneva). pp 168-73 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The plans for constructing a set of proton intersecting storage

rings attached to the CERN proton synchrotron are presented. (B.G.D.)

29727 CHARACTERISTIC FEATURES OF THE CERN ISR MAGNET SYSTEM. Keil, E.; Resegotti, L. (CERN, Geneva). pp 173-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Several characteristic features of the CERN ISR magnet system are discussed. These are the superperiodicity of the main magnet structure, sextupole component in the field pattern, distributed corrections by means of poleface windings, and superposition of closed orbits and vertical beam steering. (B.G.D.)

29728 VACUUM PROBLEMS RELATED TO COLLIDING BEAM EXPERIMENTS WITH THE CERN INTERSECTING STORAGE RINGS. Calder, R.; Fischer, E. (CERN, Geneva). pp 179-82 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The cryopump characteristics and pumping of the interaction of the interaction region in the CERN intersecting storage rings are discussed. (B.G.D.)

29729 EXPERIMENTAL AREAS AND INTERACTION REGIONS OF THE CERN INTERSECTING STORAGE RINGS. Bonaudi, F. (CERN, Geneva). pp 183-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The layout of the CERN intersecting storage ring project is presented with emphasis on the colliding beam areas and external beam area. (B.G.D.)

29730 SOME EXPERIMENTS WITH THE CERN ELECTRON STORAGE AND ACCUMULATION RING (CESAR). Hansen, S.; Jones, E.; Koziol, H.; Pentz, M. J. (CERN, Geneva). pp 189-94 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The first series of beam lifetime and stacking measurements on CESAR (CERN electron storage and accumulation ring) are reported. (B.G.D.)

29731 STATUS OF DESIGN, CONSTRUCTION, AND RESEARCH PROGRAMS AT SLAC. Ballam, J.; Loew, G. A.; Neal, R. B. (Stanford Univ., Calif.). pp 210-28 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The status of the most important components and subsystems of the Stanford linear accelerator are discussed. Topics include the accelerator structure, klystrons, drive and phasing systems, high power modulators, injector system, positron source, beam guidance and diagnostic equipment, trigger system, vacuum system, alignment system, and beam switchyard. Preliminary tests in sectors 1 and 2 are summarized. Initial research programs are briefly described. (B.G.D.)

29732 THE 360 MeV TRAVELING-WAVE LINEAR ACCELERATOR. Valter, A. K.; Grishaev, I. A.; Makhnenko, L. A.; Demianenko, G. K.; Zykov, A. I.; Ivanov, G. M.; Rubtzov, K. S.; Skuhko, V. A. (Ukrainian Physical-Technical Inst., Kharkov). pp 228-32 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Several aspects of a 360 MeV travelling-wave linear accelerator are discussed. These are determination of accelerating system electrodynamic parameters, radial movement and forming of beams, and exploitation of accelerators and accelerator parameters. (B.G.D.)

29733 2 GeV TRAVELING WAVE ELECTRON ACCELERATOR. Valter, A. K. (Ukrainian Physical-Technical Inst., Kharkov); Grishaev, I. A.; Eremenko, E. V.; (and others). pp 233-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Some results of adjusting the Kharkov 2-GeV electron linear accelerator are presented. (B.G.D.)

29734 IMPROVEMENTS IN THE RESEARCH CAPABILITY OF THE CAMBRIDGE ELECTRON ACCELERATOR. Paterson, J. M. (Harvard Univ., Cambridge, Mass.). pp 238-41 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Improvements in beam intensity, duty cycle, availability of beam time, and versatility in accelerator operation of the Cambridge electron accelerator are discussed. (B.G.D.)

29735 BONN 2.3 GeV SYNCHROTRON. pp 241-2 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A description of the Bonn 2.3-GeV electron synchrotron is presented. The main parameters along with a plan view of the accelerator are also presented. (B.G.D.)

29736 CORNELL 10 GeV ELECTRON SYNCHROTRON. McDaniel, B. D. (Cornell Univ., Ithaca, N. Y.). pp 245-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The development of a 10-GeV electron synchrotron at Cornell is discussed. Topics included are the magnets and magnet excitation circuits, general configuration of the accelerator, and the main parameters of the system. (B.G.D.)

29737 A 12 GeV ELECTRON SYNCHROTRON PROJECT. pp 249-52 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The development of a 12-GeV electron synchrotron is discussed. Topics include the main parameters, magnets and power supplies, injector and rf parameters, and cost estimates. (B.G.D.)

29738 COMPUTER STUDIES OF CAPTURE OF LARGE INJECTED BEAMS INTO AN ELECTRON SYNCHROTRON. Donald, M. H. R.; Thompson, D. J. (Daresbury Nuclear Physical Lab., Eng.). pp 252-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A computer study was made on the transient problem at injection into an electron synchrotron. The calculations were carried out for the parameters appropriate to NINA. (B.G.D.)

29739 MEASUREMENT OF THE SYNCHROTRON RADIATION IN THE X-RAY REGION. Haensel, R. (Institut fuer Experimentalphysik, Hamburg); Bathow, G.; Freytag, E. pp 257-60 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Experimental investigation of the angular and spectral distribution of synchrotron radiation in the x-ray region is reported. (B.G.D.)

29740 PHYSICS WITH ELECTRON STORAGE RINGS. Touschek, B. (Univ., Rome). pp 263-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A review article is presented on electron storage rings. Topics discussed are colliding beam experiments; synchrotron radiation; and beam lifetime, intensity, and stability. (B.G.D.)

29741 ORSAY STORAGE RING GROUP. pp 271-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Various changes in the design and performance of the Orsay storage ring are discussed. Topics include the magnetic elements, vacuum chamber, injection system, beam observation and measurements, electron and positron beams, and detection systems. (B.G.D.)

29742 BEAM CONTROL SYSTEM OF THE ELECTRON STORAGE RING VEP-1. Zinin, E. T.; Korobeynikov, L. S.; Kulipanov, G. N.; Lazarenko, B. L.; Matveev, Yu. G.; Popov, S. G.; Skrinskii, A. N.; Starodubtseva, T. P.; Tumaikin, C. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 276-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The possibility of carrying out physical experiments in colliding beam machines depends considerably upon precision of beam control and measurement of main parameters of stored beams. The description of such systems used at various stages of adjustment and investigation on machine VEP-1 is given. (auth)

29743 BEAM ENLARGEMENT IN STORAGE RINGS BY MULTIPLE COULOMB SCATTERING. Bruck, H.; Le Duff, J. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp 284-6 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The enlargement of the beam owing to small multiple Coulomb interactions between the particles is calculated. The multiple effect is complementary to the Touschek lifetime effect which arises from large scattering. (B.G.D.)

29744 INFLUENCE OF LINEAR COUPLING ON RADIATION DAMPING AND EQUILIBRIUM BEAM SIZES IN ELECTRON STORAGE RING. Leleux, G. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp 286-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

In an electron storage ring, damping rates and equilibrium sizes of the beam can be modified by using a strong coupling between transverse oscillations modes. Theoretical results of

general interest and numerical results for the Orsay storage ring (ACO) are presented. (auth)

29745 BEAM CURRENT LIMITATIONS IN THE AGS WITH MULTIPLE-TURN INJECTION RELATED TO ION SOURCE EMITTANCE CHARACTERISTICS. van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). pp 308-10 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The consequence that the ion source emittance (two dimensional phase space) increases linearly with beam output current is discussed in relation to optimum ACS intensity if multiple-turn injection is used. (B.G.D.)

29746 BEAM INSTABILITIES IN THE PRINCETON-STANFORD STORAGE RINGS. Barber, W. C. (Stanford Univ., Calif.); Gittelman, B.; O'Neill, G. K.; Richter, B. Contract AT(04-3)-515. pp 330-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A summary is presented on the most salient features of beam instabilities in the Princeton-Stanford storage rings. Topics include vertical instabilities of a single beam, vertical instabilities associated with the interaction between two beams, and changes in radial and azimuthal size of a single beam. (B.G.D.)

29747 EXPERIMENTAL RESULTS ON BEAM-BEAM INTERACTION. Auslander, V. L.; Kulipanov, G. N.; Mishnev, G. I.; Naumov, A. A.; Popov, S. G.; Skrynskii, A. N.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 335-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A survey of the preliminary results on beam–beam phenomena study obtained with the electron storage ring VEP-1 is presented. The behavior of the positron beam in presence of the electrons in the storage ring VEPP-2 is described. (B.G.D.)

29748 DAMPING OF THE COHERENT VERTICAL BEAM INSTABILITY IN THE ARGONNE ZGS. Martin, J. H. (Argonne National Lab., Ill.); Winje, R. A.; Hilden, R. H.; Mills, F. E. pp 347-50 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The equipment necessary for monitoring and damping of the coherent vertical beam instability in the Argonne ZGS is described. (B.G.D.)

29749 EXPERIMENTS ON BEAM SURVIVAL AND NON-LINEAR RESONANCES IN THE CERN PS. Baconnier, Y.; de Raad, B.; Steinbach, Ch. (CERN, Geneva). pp 350-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The observation of beam instabilities in the Stanford 500 MeV electron storage ring has raised questions concerning the stability of the beams in the 28 GeV proton storage rings (ISR) which will be built at CERN. Computer calculations were made based on a model of nonlinear perturbations of betatron oscillations. The calculations show no increase in betatron oscillation amplitudes in one million intersections with a perturbation strength corresponding to the ISR. An experiment was also performed on the CERN 25-GeV proton synchrotron in order to obtain more information about the effects of nonlinear perturbations. (B.G.D.)

29750 SOME ASPECTS OF BEAM BEHAVIOR IN NIMROD. Gray, D. A.; Billinge, R.; Harold, M. R.; Rees, G. H. (Rutherford High Energy Lab., Chilton, Eng.). pp 355-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Several aspects of the beam behavior in NIMROD are presented. Topics include the effects of pole-face winding corrections, evidence for space charge effects at injection, resistive wall vertical instabilities, and measurement of Q value. (B.G.D.)

29751 INSTABILITY OF COHERENT BEAM OSCILLATIONS IN ACCELERATORS AND STORAGE RINGS. Balbekov, V. I.; Kolomenskii, A. A. (Lebedev Inst. of Physics, Moscow). pp 358-61 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The characteristics of coherent beam oscillations in accelerators and storage rings in an arbitrary resistive medium are discussed. (B.G.D.)

29752 QUASILINEAR THEORY OF LONGITUDINAL SPACE-CHARGE EFFECT IN PARTICLE ACCELERATORS. Perelshtein, E. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 362-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The equations of quasilinear theory developed in the theory of plasma oscillation, particularly its modification for periodic instabilities, are used for determining beam instabilities in accelerators. (B.G.D.)

29753 COHERENT SYNCHROTRON OSCILLATIONS IN ACCELERATORS WITH PHASE LOCK. Lebedev, A. N.; Zhilkov, E. A. (Lebedev Inst. of Physics, Moscow). pp 364-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The application of phase-lock systems for precise correction of accelerating field frequency permits a considerable increase in the main mode of coherent oscillations (center-of-mass oscillations). However, a new problem which arises concerning the stability of other modes (the stability of bunch size, shape, orientation, etc.) is discussed. (B.G.D.)

29754 LONGITUDINAL MOTION OF PARTICLES IN THE ELECTRON SYNCHROTRON AT FIRST FEW REVOLUTIONS. Kheifets, S. A. (Inst. of Physics, Erevan). pp 367-71 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The electromagnetic oscillations generated in the resonant cavities of an electron synchrotron are discussed. These oscillations are generated as a consequence of the frequency of motion of particle bunches coinciding with that of the accelerating field which in the electron synchrotron is practically equal to the proper frequency of the accelerating gaps (resonant cavities). (B.G.D.)

29755 COMPUTER RESULTS ON NON-LINEAR PARTICLE-BEAM INTERACTIONS (FOR 10^5 REVOLUTIONS) IN THE ORSAY STORAGE RING. Beck, R. A.; Gendreau, G. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp 371-3 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The behavior of a single positron colliding with an actual electron beam during 10^5 turns in the Orsay storage ring is investigated and the results are extrapolated to the case of a weak positron beam. (B.G.D.)

29756 RESONANCE INDUCED BY SPACE-CHARGE FORCES. Bovet, C.; Hereward, H. G. (CERN, Geneva). pp 373-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Two sets of new quadrupoles placed in 25 equally spaced mid-F straight sections and 25 equally spaced mid-D straight sections and intended for the adjustment of the Q values at injection in the CERN proton synchrotron are described. After installation of such an arrangement of lenses a substantial 25th harmonic perturbation is introduced. With nominal Q values of 6.25 this is approximately the harmonic for exciting the quarter-integer resonance. The possibility of achieving this phenomenon in the presence of space-charge forces is discussed. (B.G.D.)

29757 EFFECTS OF ELECTROMAGNETIC INTERACTION BETWEEN PARTICLES AND COLLIDING BUNCH. Derbenev, Ya. S.; Mishnev, S. I.; Skrinskii, A. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 375-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The influence of the electromagnetic field of a colliding bunch on betatron oscillations of particles from a low intensity bunch in azimuthally symmetric type of weak focusing electron–electron storage ring (the influence of small bunch on the colliding bunch particles is negligible). (B.G.D.)

29758 TRANSVERSE RESISTIVE WALL INSTABILITY OF EXTREMELY RELATIVISTIC BEAM OF ELECTRONS AND POSITRONS. Ferlenghi, E. (CNEN, Frascati, Italy); Pellegrini, C.; Touschek, B. pp 378-81 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Experimental results from an investigation on the transverse resistive wall instability of extremely relativistic beams of electrons and positrons are summarized. (B.G.D.)

29759 CURRENT LIMITATIONS IN ACCELERATOR IMPOSED BY ULTIMATE DENSITY OF PARTICLES IN PHASE VOLUME OF INJECTOR. Sivkov, Yu. P.; Solnyshkov, A. I. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 382-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The value of current which can be injected into an accelerator at a preset energy from a source of a given type is limited. This results from the fact that the region of initial conditions of betatron oscillations in an accelerator is restricted by the acceptance surface. (B.G.D.)

29760 ACCELERATOR DEVELOPMENTS IN NOVOSIBIRSK. pp 389-402 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The program of the Novosibirsk Institute of Nuclear Physics dealing with accelerators which consists of the development of plasma accelerators, ironless pulse accelerators, machines with colliding beams, and special accelerators for industrial uses is briefly described. The description of the works with colliding beams as well as some ideas about storage of high positron and proton beams is also presented. (B.G.D.)

29761 PROGRESS REPORT ON THE 500 MeV ISOCHRONOUS CYCLOTRON MESON FACTORY OF ETH ZURICH. Willax, H. A.; Blaser, J. P. (Eidgenoessisches Technische Hochschule, Zurich). pp 413-18 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The proposed research activities, organization, and accelerator development at the 500 MeV isochronous cyclotron meson factory of Eth Zurich are discussed. (B.G.D.)

29762 MESON FACTORIES IN USSR. Dmitrievskii, V. P.; Kolga, V. V.; Polumordvinova, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 418-31 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A method for varying frequency oscillations in a relativistic cyclotron at a given radius is discussed. The ion optics of beam extraction, transport, and analysis for 2.4-m isochronous cyclotron are described. Finally, an isochronous cyclotron for accelerating particles with varying energy is also described. (B.G.D.)

29763 RECENT PROGRESS ON A SUPERCURRENT SEPARATED ORBIT CYCLOTRON. Livingston, R. S.; Martin, J. A.; Worsham, R. E.; Hudson, E. D.; Lord, R. S.; Mann, J. E.; Mosko, S. W.; Ziegler, N. F.; Richardson, E. G. Jr.; Howell, L. N. (Oak Ridge National Lab., Tenn.). pp 431-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The development of a 10- to 50-MeV separated orbit cyclotron is discussed. Topics include the focusing system, magnets, radio-frequency cavities, and the limits of current in the separated orbit cyclotron. (B.G.D.)

29764 PARTICLE ACCELERATION BY COUNTER WAVES. Veksler, V. I.; Yarkovoi, O. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 439-42 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The possibility of accelerating charged particles to ultra-relativistic energies in the high frequency potential well produced by a field of two counter waves are discussed. (B.G.D.)

29765 ACCELERATION OF CHARGED PARTICLES IN A FIELD OF A SLOWED DOWN PLANE WAVE. Bonch-Osmolovskii, A. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 442-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

It is shown that in a slowed down plane wave, the phase velocity is equal to the velocity of a particle, and in a longitudinal constant magnetic field it is possible to accelerate a charged particle. (B.G.D.)

29766 ABOUT THE USE OF RELAXATION OSCILLATIONS FOR PARTICLE ACCELERATION IN RING ACCELERATORS. Vasil'ev, A. A. (Radiotechnical Inst., Moscow). pp 448-50 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The possibilities of using relaxation oscillations for particle acceleration in ring accelerators is discussed. It is shown that the use of regular relaxation oscillations may be favorable in some cases because of bigger separatrix, amplifying elements of the power cascades work in a high efficient mode, and the oscillation frequency can be simply changed. (B.G.D.)

29767 FUNDAMENTAL PROPERTIES OF NON-LINEAR FOCUSING. Vecheslavov, V. V.; Orlov, Yu. F. (Inst. of Nuclear Physics, Novosibirsk. Inst. of Physics, Erevan). pp 451-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A study is presented which deals with a simple model of non-linear focusing having no immediate practical value, but, due to its simplicity permitting to carry out a fairly complete analysis of all the fundamental properties of nonlinear focusing. (B.G.D.)

29768 EXPERIMENTAL BEAMS AND FACILITIES AT THE ARGONNE ZGS. Blewett, M. H. (Argonne National Lab., Ill.). pp 461-3 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The experimental facilities which include the proton and meson areas of research, and extraction and detection equipment are described. (B.G.D.)

29769 TARGETING TECHNIQUES AND CONSIDERATIONS ON THE ZGS. Martin, R. L.; Daniels, R. E.; Marcowitz, S. M.; Ratner, L. G. (Argonne National Lab., Ill.). pp 464-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A survey of the targeting techniques in use on the ZGS is presented. No thorough study of targeting efficiencies has yet been undertaken at Argonne. (auth)

29770 SLOW AND FAST BEAM EJECTION FROM A SHORT STRAIGHT SECTION OF THE CERN PROTON SYNCHROTRON. Bovet, C.; Nakkasyan, A.; Reich, K. H. (CERN, Geneva). pp 488-93 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Various aspects of slow and fast beam ejection from a short straight section of the CERN proton synchrotron are discussed. These are choice of straight section, orbit deformation, ejection magnet, external beam, beam observation and monitoring, performance, and future improvements to the system. (B.G.D.)

29771 CERN MUON STORAGE RING. Bailey, J.; Brown, R.; Farley, F. J. M.; Giesch, M.; Picasso, E.; van der Meer, S. (CERN, Geneva). pp 493-6 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The CERN muon storage ring which will be used to store muons of momentum 1.3 GeV/c thus dilating the lifetime to 27 μsec is described. (B.G.D.)

29772 HIGH-ENERGY MONOCHROMATIC AND MONITORED NEUTRON BEAMS. Santangelo, R. (Istituto di Fisica, Padua. Istituto Nazionale di Fisica Nucleare, Padua). pp 504-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A method for production of high-energy neutron beams which are resonably monochromatic and collimated and have monitored flux is presented. The method consists of using two beams, one of high-energy deuterons and the other of electrons or gamma rays travelling parallel or antiparallel to each other, in which after collision the disintegration of the deuteron takes place thereby producing two other collimated beams; one of neutrons and the other one of protons, both having one half the momentum of the original deuterons. (B.G.D.)

29773 CHROMATIC ABERRATIONS IN MAGNETIC OPTICS. Cartashev, V. P.; Kotov, V. I. (High Energy Physics Inst., Serpukhov, USSR). pp 514-18 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Multidimensional matrices for quadrupole lenses without using approximation of the thin lenses and bending magnets with an axial-symmetrical field are determined; the chromatic aberrations in a doublet, symmetrical quartet, and a chromatic system for 90° deflection of a parallel beam are considered. (auth)

29774 DESIGN PROBLEMS IN THE BEAM SWITCHYARD OF THE STANFORD LINEAR ACCELERATOR. Neet, D. A. G. (Stanford Univ., Calif.). pp 518-24 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The design problems dealing with radiation exposure, induced radioactivity, formation of corroding gases, and limited access to equipment in the beam switchyard of the Stanford linear accelerator are discussed. (B.G.D.)

29775 SOME DEVELOPMENTS OF TARGETING TECHNIQUES AT NIMROD. Gray, D. A.; Bennett, R. G. T.; Egginton, A. J.; Mathews, W. A. (Rutherford High Energy Lab., Chilton, Eng.). pp 524-8 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Several targeting techniques at NIMROD are discussed. These are normal counter spill on flat-top, noise spill on current rise, noise spill on flat-top, bubble chamber spill during current rise, bubble chamber spill during flat-top, normal magnet spill on flat-top retaining some trapped beam, continuous shaving of beam on flat-top, and combination of target spills. (B.G.D.)

29776 PHYSICS WITH POLARIZED PARTICLES. Hughes, V. W. (Yale Univ., New Haven). pp 531-45 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The status of high-energy physics with polarized particles is reviewed. Topics included are information from studies with polarized particles, polarized beams, polarized targets, and high-energy experiments with polarized targets. (B.G.D.)

29777 DESIGN AND APPLICATIONS OF R.F. DEFLECTING STRUCTURES AT SLAC. Loew, G. A.; Altenmueller, O. H. (Stanford Univ., Calif.). pp 551-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A summary is presented on the work done at SLAC on rf deflecting structures. The work described includes new results obtained with the conventional TM_{11}-type structure as well as with a new TM_{01}-type structure, a brief survey of the experimental setups used in the measurements, and the description of two immediate applications of these devices at SLAC: an electron-bunch-width analyzer and a positron–electron deflector. (B.G.D.)

29778 RADIO-FREQUENCY PARTICLE SEPARATION USING PRIMARY BEAM MODULATION. Montague, B. W. (CERN, Geneva). pp 555-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Various aspects of the CERN of separator are presented. These are a description of the present CERN rf separator, principles of primary beam modulation, primary beam and target optics, first momentum analyzer, and skew optics at the deflector RF-2. (B.G.D.)

29779 POLARIZED PROTON TARGET FOR NIMROD. Atkinson, H. H.; Belcher, B. E.; Colyer, B. F.; Downton, R. (Rutherford High Energy Lab., Chilton, Eng.). pp 559-64 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The main characteristics of a polarized proton target built for high-energy physics experiments with NIMROD are described. The target is based on dynamic polarization by the solid effect of the protons in the hydrogen atoms (the free protons) of the water of crystallization in single crystals of lanthanum magnesium nitrate $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$(LMN) containing a dilute paramagnetic impurity. (B.G.D.)

29780 PERFORMANCE OF A POLARIZED PROTON TARGET FOR HIGH ENERGY PHYSICS EXPERIMENTS AT ARGONNE. Suwa, S.; Yokosawa, A.; Khoe, T. K.; Moretti, A. (Argonne National Lab., Ill.). pp 564-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A description is presented of the polarized proton target of LMN (~1% Nd) constructed for use in high-energy physics experiments at Argonne. The operational experience achieved by using this target is briefly summarized. (B.G.D.)

29781 THE DESY POLARIZED γ-RAY BEAM. Bologna, G.; Lutz, G.; Schulz, H. D.; Timm, U.; Zimmerman, W. (Deutsches Elektronen Synchrotron, Hamburg). pp 567-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Further measurements on the DESY quasi-monochromatic and polarized γ-ray beam from a diamond radiator are reported. (B.G.D.)

29782 QUANTUM DEPOLARIZATION OF ELECTRONS IN A MAGNETIC FIELD. Bayer, V. N.; Orlov, Yu. F. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 569-72 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

In the movement of electrons and positrons in a magnetic field the emission of protons, as shown by Sokolov and Ternov (DAN, 153, 1052 (1963)) leads to their polarization. In order to keep the arising particle polarization in a storage ring it is shown that it is necessary to select the particle energy so that there would arise no depolarizing resonances in the system due to the radial and azimuthal components of the magnetic field on a particle trajectory. (B.G.D.)

29783 NUMERICAL–ANALYTICAL CALCULATION OF THE ACCELERATION OF THE POLARIZED ELECTRONS IN SYNCHROTRON. Simonyan, Kh. A. (Inst. of Physical Problems, Moscow). pp 572-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The effect of the passage of polarized electrons through a series of depolarizing resonances during the acceleration process of the Yerevan Synchrotron is estimated by the application of the perturbation theory. Another approach based on the use of a high speed computer for simultaneous calculation of the amplitudes of the oscillation harmonics and of the spin motion in various energy regions is also presented. (B.G.D.)

29784 PRODUCTION OF QUASI-MONOCHROMATIC POLARIZED BREMSSTRAHLUNG FROM A SINGLE CRYSTAL OF SILICON. Kifune, T.; Kimura, Y.; Kobayashi, M.; Kondo, K.; Nishikawa, T.; Horikoshi, G. (Tokyo Univ.). pp 575-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The possibility of producing a quasi-monochromatic polarized γ-ray beam for nuclear experiments is discussed. A 700-MeV electron synchrotron was used to bombard a silicon crystal of high purity and the intensity spectra and polarization of the bremsstrahlung produced were measured. (B.G.D.)

29785 OPERATIONAL EXPERIENCE WITH THE CPS FAST EJECTION SYSTEM. Kuiper, B.; Plass, G. (CERN, Geneva). pp 579-92 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The experience gained from the operation of the CPS fast ejection system, particularly in view of sharing the beam between several experiments is reviewed. Topics presented are an outline of the system, additional facilities and improvements, operational modes, and operational characteristics. (B.G.D.)

29786 FIRST ORDER NON-SYNCHRONOUS OPERATION OF AN ELECTRON LINEAR ACCELERATOR SECTION. Brunet, P. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp 595-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Various aspects of first order nonsynchronous operation of an electron linear accelerator section are discussed. These are optimum initial phase angle, nonsynchronous beam loading, total energy, beam induction technique of phasing, and extension of Orsay linac. (B.G.D.)

29787 CHARACTERISTICS OF BEAM FROM THE ARGONNE ZGS INJECTOR LINAC. Perry, R.; Livdahl, P. V.; Crosbie, E. A.; Gallagher-Daggitt, G. E.; Myers, W. W. (Argonne National Lab., Ill.). pp 597-602 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The phase acceptance, beam energy, and time variation of beam position and emittance of the beam from the Argonne ZGS injector linac were investigated. Two accelerating column and source arrangements were also investigated. (B.G.D.)

29788 INITIAL TESTS OF A HIGH-GRADIENT 550 kV ACCELERATING TUBE WITH A DUOPLASMATRON EXPANDED PLASMA PROTON SOURCE. Huguenin, J.; Malthouse, F.; Solinas, L.; Vosicki, B. (CERN, Geneva). pp 603-12 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The construction principles of a high-gradient 550 kV accelerating tube with a duoplasmatron extended plasma proton source are presented along with preliminary results obtained with a reentrant accelerating structure. (B.G.D.)

29789 AN APPROACH TO 200 MHz BUNCH MEASUREMENTS AND LIMITATIONS ON LONGITUDINAL PHASE PROBES. Warner, D. J. (CERN, Geneva). pp 612-17 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A method for direct studying the form of the output beam from a proton linac in the longitudinal phase plane is described. (B.G.D.)

29790 LIQUID NITROGEN COOLING OF THE LINEAR ELECTRON ACCELERATOR AT S AND C BAND. Koolhof, R. A. (Inst. for Nuclear Physics Research, Amsterdam). pp 618-21 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The construction and operating costs of liquid nitrogen cooling of electron linear accelerators which operate at S and C band frequencies are discussed. (B.G.D.)

29791 SELF-CONSISTENT PARTICLE DISTRIBUTION AND THE LIMIT CURRENT IN LINEAR ACCELERATORS. Bondarev, B. I.; Vlasov, A. D. (Radiotechnical Inst., Moscow). pp 621-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The representation of accelerated bunches by uniformly charged ellipsoids used for obtaining the limit current expression is shown to be approximately self-consistent. (B.G.D.)

29792 DEVELOPMENT OF THE CROSS-BAR STRUCTURE FOR A PROTON LINEAR ACCELERATOR. Carne, A.; Dome, G.; Fewell, N.; Juengst, W. (CERN, Geneva). pp 624-33 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The basic principles and results of the field for cross-bar structures are presented. Although an exact theory for the actual struc-

ture is extremely complicated because of the metallic boundaries, it is possible to derive the main characteristics by considering, firstly, a rectangular waveguide periodically loaded with alternating sets of bars at right angles (the two sets may have different diameters); secondly, a circular guide with bars but without drift tubes; and thirdly, a circular guide with bars and drift tubes. Semi-empirical formulas for drift tube capacitance and factor are deduced. The characteristic equations so obtained are used to give a near-optimized structure over the energy range 80 to 300 MeV, which is compared with designs of the Alvarez structure. (B.G.D.)

29793 SOME DESIGN PROBLEMS OF 1000-MeV LINEAR ACCELERATOR USED AS AN INJECTOR FOR CYBERNETIC ACCELERATOR. Andreev, V. G.; Burshtein, E. L.; Kulman, V. G.; Murin, B. P.; Nevyazhskii, I. Ch. (Radiotechnical Inst., Moscow). pp 634-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The selection of an accelerating structure to be used in a 1.0 GeV linear accelerator which is to be used as an injector for a 1000 GeV cybernetic accelerator is discussed. The most promising accelerator structure found was the cylindrical resonant cavity excited in the π-mode and loaded with conducting washers. (B.G.D.)

29794 ACCELERATING FIELD STABILIZATION IN BEAM-LOADED PROTON LINAC BY CHOOSING H.F. SUPPLY PARAMETERS AND OPERATING CONDITIONS. Murin, B. P.; Kvasha, A. I. (Radiotechnical Inst., Moscow). pp 637-41 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Methods for stabilizing the accelerating amplitude and phase by proper choice of circuit parameters and rf supply operating conditions are investigated. The investigation is carried out in terms of the equivalent resistance of the beam-loaded cavity, determined for the non-varied accelerating voltage. (B.G.D.)

29795 STUDIES ON RF STRUCTURES AT 400 Mc/s AND 800 Mc/s FOR A PROTON LINEAR ACCELERATOR. Bauer, W.; Eschelbacher, H.; Kuntze, M. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). pp 642-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

Measurements are reported on a crossbar structure at 400 MH_3 and a slotted iris structure at 800 MH_2 for use in a superconducting proton linear accelerator. (B.G.D.)

29796 TRANSVERSE MOTION OF THE PARTICLES IN LINEAR ELECTRON ACCELERATOR CAUSED BY THE ACTION OF NONSYMMETRIC WAVE. Voskressenskii, G. V.; Korosa, V. I. (Radiotechnical Inst., Moscow). pp 645-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The process of beam expansion is considered on the basis of research on electromagnetic fields excited by the beam. An analysis of the deflecting action of the field in assuming predetermined longitudinal motion of particles is presented. (B.G.D.)

29797 INTERACTION OF A BUNCHED BEAM WITH TRANSVERSE MODES IN RF CAVITIES. Gluckstern, R. L. (Univ. of Massachusetts, Amherst); Butler, H. S.; Jacobs, K. pp 649-51 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The interaction of high-current proton beams with transverse modes in a standing wave linear accelerator was studied in order to determine the seriousness of this phenomenon for present designs. (B.G.D.)

29798 ACCURATE BEAM DYNAMICS EQUATIONS IN PROTON LINEAR ACCELERATORS. Carne, A.; Lapostolle, P. M.; Prome, M. (CERN, Geneva). pp 656-62 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A correction term was derived for the phase equation $\phi_{n+1} = \phi_n + 2\pi[(\beta n,s/\beta n) - 1]$ in such a way that phase area is conserved. Accurate general relations were also derived for radial, as well as axial motion along a linear accelerator, which includes coupling terms, and such that the requirements of Liouville's theorem are satisfied. Finally, by way of example, axial motions using the new equations and a multi-integration routine are described and compared. (B.G.D.)

29799 MODERN DEVELOPMENTS OF THE MICROTRON. Kapitsa, S. P. (Inst. for Physical Problems, Moscow). pp 665-71 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A review of the principal results obtained in the study and development of a high-current microtron is presented. (B.G.D.)

29800 THE 30 MeV HIGH-CURRENT MICROTRON. Kapitsa, S. P.; Kosarev, E. L.; Lukyaenko, E. A.; Melekhin, V. N.; Nedelyaev, A. G.; Chernenko, V. M.; Zykin, L. M. (Inst. for Physical Problems, Moscow). pp 671-2 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The design and operation of a 30-MeV high-current microtron are discussed. Topics include the accelerating cavity, magnetic field, beam motion, phase oscillations, and beam current. (B.G.D.)

29801 THE CW MICROTRON. Kapitsa, S. P. (Inst. for Physical Problems, Moscow). pp 672-5 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The principal parameters and feasibility of a CW microtron are considered. The discussion is based on the experimental and theoretical experience gained in the studies of pulsed microtrons. (B.G.D.)

29802 A 200 MeV SUPERCONDUCTING RACETRACK MICROTRON. Wiik, B. H.; Schwettman, H. A.; Wilson, P. B. (Stanford Univ., Calif.). pp 686-90 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A 200-MeV superconducting racetrack microtron is proposed. Calculations of phase stability and beam optics were made for the proposed machine. In addition, the properties of both superconducting and conventional rf systems were investigated. (B.G.D.)

29803 MEASUREMENTS AT HIGH ELECTRIC FIELD STRENGTHS ON SUPERCONDUCTING ACCELERATOR CAVITIES. Schwettman, H. A.; Wilson, P. B.; Churilov, G. Y. (Stanford Univ., Calif.). pp 690-2 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The behavior of two cavities with an electric field at the surface, a cylindrical cavity operating in the TM_{010} mode and a disk-loaded structure operating in the $2\pi/3$ mode, was investigated. These cavities are of direct interest for accelerator applications. A peak electric field of 1.5×10^8 volts/cm, which is adequate for particle acceleration, was achieved. (B.G.D.)

29804 ADONE: THE FRASCATI 1.5 GeV ELECTRON POSITRON STORAGE RING. Amman, F.; Andreani, F.; Bassetti, M.; (and others) (CNEN, Frascati, Italy). pp 703-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A status report is presented on Adone the Frascati 1.5-GeV electron positron storage ring. Topics included are expected performance, main parameters, injection optics, magnet and magnet power supply, vacuum system, rf system, buildings, and expected operation schedule. (B.G.D.)

29805 NUMERICAL COMPUTATIONS OF SPACE CHARGE EFFECTS IN A POSITRON AND ELECTRON STORAGE RING. Bassetti, M. (CNEN, Frascati, Italy). pp 708-9 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The interaction effect between two beams are simulated with the following approximations: thin lens approximation; vertical effect only, supposing the beams are sheet-like, and each beam schematized as having 1000 particles. (B.G.D.)

29806 CHROMATIC ABERRATIONS IN A PERIODIC AG BEAM TRANSPORT SYSTEM. Regenstreif, E. (Faculte des Sciences, Rennes, France). pp 717-18 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The transverse and longitudinal chromatic aberrations are described in two basic planes of a periodic AG beam transport system. (B.G.D.)

29807 INTERFERENCE RESISTANCE OF BEAM PICKUPS IN MODERN ACCELERATORS. Karabekov, I. P. (Academy of Sciences, Moscow). pp 719-21 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The results obtained during investigation of a very important parameter of pickups, namely their susceptibility to interferences due to various factors are presented. (B.G.D.)

29808 FIELD HARMONIC ANALYSIS AND REQUIREMENTS FOR ACCURACY OF MAGNETIC QUADRUPOLE LENS MANUFACTURE. Doinikov, N. I. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 721-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A technique is proposed for designing profile ruling and the harmonic analysis of the field of the lenses with the form close

to hyperbolic and a direct relation is established as well between the amplitudes of low harmonics (k = 1 + 6). (B.G.D.)

29809 ENERGY FLOW AND TRANSIENTS IN THE ALVAREZ STRUCTURE. Hereward, H. G.; Lapostolle, P. (CERN, Geneva). pp 742-7 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

A transmission line equivalent circuit is presented for an Alvarez structure along with a more complete treatment based on a cylindrical waveguide model. (B.G.D.)

29810 ION ACCELERATOR. Ota, Susumu (to Nissin Electric Co., Ltd.). Japanese Patent 1966-10320. May 16, 1966. Filed Apr. 18, 1961.

In the ion accelerator proposed, a tubular conductor is used as the high-frequency coil wound around the ion source. Thus, by passing coolant through this tube, the ion source can be cooled economically and with the simple structure. A tubular conductor is used as the high-frequency coil, to serve also as the cooling tube. (NSA of Japan)

29811 PARTICLE ACCELERATOR. Adachi, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9755. May 25, 1966. Filed June 11, 1965.

In the particle accelerator proposed, two different series of accelerating electrodes are installed in the insulating cylindrical body, and two different particles, viz. electrons and ions, can be injected and accelerated at the same time. It consists of the following: the insulating cylindrical body; the (1st) end-plate fixed air-tight at one end of the cylindrical body; the (2nd) end-plate fixed air-tight at the other end of the cylindrical body; the air-tight chamber formed by the cylindrical body and the two end plates; the (1st) particle source and the (2nd) target installed air-tight on the 1st end plate; the (1st) target and the (2nd) particle source whose polarity is opposite to the 1st source, installed air-tight on the 2nd end plate; the (1st) series of accelerating electrodes, between the 1st particle source and the 1st target; the (2nd) series of accelerating electrodes between the 2nd target and the 2nd particle source; the power source, in common, for supplying the accelerating voltage to both the 1st and 2nd series of accelerating electrodes. (NSA of Japan)

29812 CHARGED-PARTICLE ACCELERATOR. Utsunomtya, Shinpachi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9756. May 25, 1966. Filed July 23, 1965.

In the charged-particle accelerator proposed, charged particles are accelerated by means of the high dc accelerating voltages, obtained by rectifying the outputs of the high-voltage transformers connected in cascade. The accelerator consists of the following: the accelerating, high dc voltage source in which rectifier elements with the same rectifying directions are connected in series, connected to the respective secondary windings of a plurality of transformers; a device for smoothing the accelerating dc voltages by means of the floating capacities occurring between the rectifying output voltage terminals (to the secondary windings) either by the condensers connected, in parallel, to the terminals or by the parts connected to the terminals; a charged-particle source; the accelerating tube in which charged particles are accelerated by the dc voltages; a device for injecting a charged-particle pulse of a given width with the maximum accelerating-voltage as the center, into the accelerating tube, sychronized with the maximum voltage; and the high-pressure tank containing the above respective components. (NSA of Japan)

29813 CIRCULAR-TYPE ELECTRON ACCELERATOR. Kaneko, Takeo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9757. May 25, 1966. Filed Apr. 2, 1965.

In the circular-type electron accelerator proposed (like the betatron), special coils are provided for correcting the high-intensity magnetic field. The circular accelerating tube is installed between the two cylindrical magnetic poles (which are in a pair), each of which surrounds the respective central magnetic pole. And electrons are accelerated through the circular tube by forming the timewise-changing magnetic field between the two cylindrical magnetic poles. Each central magnetic pole is wound with a coil, and a dc electric current is passed through this coil for correcting the nonuniformity of the high-intensity magnetic field. (NSA of Japan)

29814 CIRCULAR-TYPE PARTICLE ACCELERATOR WITH A BEAM CONTROL DEVICE. Kamei, Hisashi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9758. May 25, 1966. Filed May 12, 1965.

In the circular-type particle accelerator with a beam control device proposed, the injection into the orbit of emitted particles can be adjusted by applying a hf field, by the use of certain parameters. There are installed the following: a particle source installed at a part of the accelerating tube; the hf electrodes for controlling the particles from the source; a hf oscillator for supplying the hf voltage to the electrodes; and a device for controlling the time and period of the hf voltage supply. The injection into the orbit of particles can be adjusted by the hf field due to the hf voltage. (NSA of Japan)

29815 CIRCULAR-TYPE PARTICLE ACCELERATOR. Kaneko, Takeo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9759. May 25, 1966. Filed May 2, 1965.

In the circular-type particle accelerator proposed, a pair of coils are installed in the magnetic field produced by the electromagnet, for correcting the magnetic field between the two central magnetic poles. The circular accelerating tube is installed between the two cylindrical magnetic poles, in each of which is located a central magnetic pole. Particles are accelerated through the circular orbit by producing the timewise-changing magnetic field between the magnetic poles. Each central magnetic pole is wound with a coil for correcting the magnetic field. Thus, the magnetic field between the two central magnetic poles can be corrected by means of the magnetic field of the same pH phase as the magnetic field produced by the electromagnet, which is produced by the voltage induced in the coils. (NSA of Japan)

29816 METHOD FOR INJECTING PARTICLES IN A PARTICLE ACCELERATOR. Miyazawa, Tatsuo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9760. May 25, 1966. Filed May 13, 1965.

By the method proposed, the injection into the orbit of electrons can be increased, not affected by the space charge effect; this leads to the increased output of x-rays for example and to the lengthened life of an electron gun. The method includes the following: a device for extracting the control signal, which is installed in the magnetic field of the particle accelerator; a device for delaying the output signal until the time the 1st pulse of particles is injected; a device for producing the rectangular wave of the width corresponding to the time the 2nd pulse is injected, by means of the output of the above device; a device for producing a pair of the pulses whose polarities are opposed to each other, by differentiating the rectangular wave; a pulse generator for producing the two corresponding pulses to control the electron gun; and a device which converts the pulse signals into the high voltage to be supplied to the electron gun. (NSA of Japan)

29817 LINEAR ACCELERATOR. Shigemura, Sunao (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-10000. May 27, 1966. Filed July 12, 1965.

An improved linear accelerator is proposed. It consists of the following: an electron gun for emitting electrons; a long, cylindrical accelerating tube, which has a plurality of cavities given by a plurality of metal discs; a hf power source, connected to the accelerating tube, for focusing and accelerating the electrons; focusing coils installed surrounding the accelerating tube; and dielectric or metal inserted in the cavities whose amount can be varied, for adjusting the resonance frequency in the cavities. (NSA of Japan)

29818 ACCELERATOR WITH A PULSED OUTPUT. Machiyama, Yoshihiko (to Mitsubishi Heavy Ind., Ltd.). Japanese Patent 1966-10553. May 18, 1966. Filed May 30, 1964.

In the linear accelerator proposed, the average output with respect to time of accelerated pulsed particles is stabilized. It consists of the following: a trigger oscillator to control the pulse-power source; the pulse-power circuit controlled by the trigger oscillator; the microwave-producing circuit controlled by the output of the pulsed-power source; the accelerating tube with the accelerating electric field controlled by the output of the microwave-producing circuit; a device for detecting the accelerator output and comparing it with the preset value; and a device for changing the oscillation frequency of the oscillator so that the difference between the detected and the preset output may become zero. (NSA of Japan)

29819 ACCELERATING TUBE FOR A LINEAR ACCELERATOR. Goto, Masayuki (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1966-9520. May 9, 1966. Filed Dec. 3, 1963.

An improved accelerating tube is proposed for a linear accelerator. In the linear accelerating tube, both the long cylindrical tube and the accelerating disc electrodes are made of aluminum. (NSA of Japan)

29820 COOLING DEVICE FOR A LINEAR ACCELERATING TUBE. Hatano, Hisakazu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9280. May 4, 1966. Filed Oct. 22, 1961.

A cooling device is proposed for use in a linear accelerating tube. The linear accelerating tube is a kind of microwave guide, and the resonance frequency is subject to fluctuations due to ther-

mal expansion. A heating device is also provided to heat the coolant, which allows the cooling tube to be used for heating as well. (NSA of Japan)

29821 PROGRESS IN NUCLEAR TECHNIQUES AND INSTRUMENTATION. VOLUME 2. Farley, F. J. M. (ed.). New York, John Wiley and Sons, Inc., 1967. 347p. $16.00.

Four articles are included on the production and acceleration of ion beams in the tandem accelerator; particle separation at high energies; beam extraction techniques for synchrotrons; and bubble chamber measurements and their evaluation. Separate abstracts are prepared for each. (L.B.S.)

For abstracts of individual sections see: 28220, 29685, 29686, and 30035.

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 28339, 29361, 29970, and 30038.

29822 (DP-MS-67-10) SPECTRAL INDEX AND RELAXATION LENGTH DETERMINATIONS IN BORATED D_2O AND H_2O. Baumann, N. P.; Parks, P. B.; Pellarin, D. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). [nd]. Contract AT(07-2)-1. 21p. (CONF-670707-1). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

Spectral index measurements with paired Lu–Cu and ^{239}Pu–Mn foils were used to determine the thermal-neutron energy equilibria in boron-poisoned H_2O and D_2O. The results were found to depend not only on the amount of poison and the diffusion properties of the moderator but also on the type of neutron source feeding the experimental samples. Thermal neutrons ("space" feed) were obtained from a thermal column of a reactor. Epithermal neutrons (slowing-down or "energy" feed) were supplied by leakage neutrons from the same reactor or from a neutron generator supplying 14-MeV neutrons. For both H_2O and D_2O the experimental spectral index is much larger for energy feed than for space feed. Monte Carlo calculations using the Brown–St. John (BSJ) kernel and THERMOS computations using both the BSJ kernel and Honeck's adaption of the Nelkin kernel were in close agreement with each other and with the experiments when the source feed was properly characterized. The cause of the spectral index variation with source conditions is not the same for the two moderators. Detailed examination of the computations suggest that this difference for D_2O is largely ascribable to a true difference in the Maxwellian distribution whereas for H_2O the difference is almost entirely due to subcadmium epithermal (1/E) activations. The measurements in D_2O were extended to high boron concentrations in order to ascertain the observable effects of a formal limit to equilibrium conditions when the neutron diffusion length, L, approached $1/\Sigma_s$. If the source feed neutrons are at the normal neutron temperature of 20°C, relaxation-length measurements suggest an approach to equilibrium near the interface, but the spectral index measurements indicate that spectral hardening continues deep into the sample, i.e., that equilibrium is not obtained. However, when 1/v-law filters were interposed between the source and the diffusing medium to harden the spectrum to the equilibrium value computed by THERMOS no spatial dependence was observed for relaxation lengths or spectral indices over the entire experimental range. This result indicates that the effects of the formal limit are not always readily experienced and thus the limit must be re-expressed in terms of effective energy cutoff limits in order to be experimentally observable. (auth)

29823 (EIR-98) ZUR ANALYTISCHEN LOESUNG DER ENERGIEABHAENGIGEN NEUTRONEN-TRANSPORTGLEICHUNG IN S_N-FORMULIERUNG. (Analytical Solution of the Energy-Dependent Neutron Transport Equations in the S_N Formulation). Beuchat, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nov. 1966. 94p. (In German). Dep.

An attempt was made to find an analytical solution of the S_N differential equation for the case of a cylindrical symmetrical arrangement (the case of a plain arrangement is contained in this arrangement as a special case). The following problems were treated extensively: explicit solution of the S_N differential equation in vacuum, solution of the S_N differential equation by Lie series at a development stage $r_0 \neq 0$, solution of the S_4 differential equations at the singular development place $r_0 = 0$ with special series, solution of the S_4 differential equations at the site $r_0 \neq 0$ using the Lie series, convergent detection of the solution of the latter two, solution of the S_N differential equation at the singular development site $r_0 = 0$ using a special series recursion, and detailed statement of the preceding in the solution of a concrete boundary value problem. The basic studies were carried through to permit the complete analytical solution of the S_N differential equation. These analytical solutions have with respect to the usual S_N solutions the advantage of accuracy which can be assumed independent of the calculation method. The analytical solutions are so developed that in the case of long convergents or in the case of numerical instabilitity the possibility of analytical continuation is given. A generalization of the analytical method to multidimensional problems appears possible. (tr-auth)

29824 (EIR-110) LIE–PN, P_n-SPHERICAL HARMONICS, MULTI-GROUP, MULTI-REGION PROGRAMME. Alpiar, Ronald (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Apr. 1967. 42p. Dep.

A program is described which solves the time-independent neutron transport equation in a multi-region r-geometry reactor cell. The transport equation is broken down into sets of spherical harmonic equations (the P_n method), and the latter are solved for multi-group fluxes by the Lie method. Reflective outer boundary conditions are applied, though the user may also feed in special boundary conditions in the form of a boundary-moment matrix. In homogeneous problems a very wide choice of eigenvalue parameters includes the possibility of simultaneously varying zone radii and material constants in the eigenvalue search. Source problems may also be fed in. The whole program is written in FORTRAN, all arrays being dynamically dimensioned and positioned in order to make most economical use of core storage: preparation of input data is on the "format-free" principle. Particular attention has been paid to making the program competitive in running time with similar codes. This report contains some basic theory and the mathematics of its application in the program–instructions for data preparation, description of program output, and tables of typical running times. (auth)

29825 (EIR-115) P_N-THEORY IN r-θ-GEOMETRY. Auerbach, T.; Mennig, J. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Apr. 1967. 54p. Dep.

Kofink's method of solving the transport equation in P_N approximation was extended to r-θ geometry. It is shown how the treatment may be applied to multigroup theory. Two types of interface boundary conditions are discussed. Since the method is primarily intended for use with heterogeneous theory, no cell boundary is defined. Instead, there is a condition on the asymptotic behavior of the scalar flux. Numerical results are given for monopole and dipole extrapolation lengths at the surface of a natural uranium rod immersed in D_2O. (auth)

29826 (EUR-3457.e) ELEMENTARY METHODS IN FAST NEUTRON TRANSPORT THEORY. Syros, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Apr. 1967. 182p. Dep.

Some new methods for the transport theoretical treatment of fast neutron slowing-down problems are described. These methods make wide use of integral transform techniques. One of the main ideas developed is the expansion of the neutron propagator in an infinite series of which the inverse is summable. An interesting problem in the slowing-down theory is the calculation of the distribution of neutrons which have been scattered inelastically. This problem was solved both for discrete and continuous distribution of the nuclear levels. Finally a perturbation theoretical method was developed and another method allowing for the introduction of the central limit theorem of the theory of random variables into the transport theory was worked out. (auth)

29827 (GA-7439) DIFFERENTIAL NEUTRON THERMALIZATION. Annual Summary Report, October 1, 1965–September 30, 1966. Whittemore, W. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Feb. 10, 1967. Contract AT(04-3)-167. 63p. Dep. CFSTI.

The General Atomic Neutron Velocity Selector was used to study the details of neutron scattering in liquid parahydrogen, liquid D_2O, and reactor-grade graphite. The scattering into various angular directions between 30 and 150° was studied for incident neutrons with energies ranging up to ~0.7 eV. The energy-transfer cross sections were evaluated for the larger values of incident energy to provide data in a region not readily accessible to experimenters, using a reactor as a source of neutrons. For the cases of D_2O and graphite, the data are also presented in terms of the scattering law. These provide information for much larger values of energy exchange (β up to 10 and above) than previous work, from which the largest values of β were in the order of 2. The cross-section data are compared in detail with theoretical results, where these are available. (auth)

29828 (GA-7683) LATTICE PHYSICS STUDIES. Quarterly Progress Report for the Period Ending December 31, 1966. Gozani, T.; Trimble, G. D.; Neill, J. M. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 25, 1966. Contract AT(04-3)-167. 41p. (EURAEC-1822). Dep. CFSTI.

Includes Appendix A.

Work Performed under United States–Euratom Joint Research and Development Program.

A neutron spectrum was measured in an erbium nitrate solution to study and hopefully eliminate the previous discrepancies observed in the resonance region. In order for this measured spectrum to be meaningfully compared with theory, the most recent compilation of the erbium cross section was obtained from BNL. The recommended resonance parameters are now being used to

calculate the cross section below 9 eV in the desirable energy mesh (101 points) by the code FASDOP. The epithermal source was studied extensively in the erbium nitrate solution using the foil activation and time-of-flight methods to check new techniques of source representation. A comprehensive literature survey and methods evaluation was undertaken on uranium and plutonium lattices. An experimental facility was designed especially for measuring neutron spectra in tightly packed lattices. The basic capabilities of this facility are increased intensity and precision alignment. Further progress was made on the probe tube perturbation using the two-dimensional transport code 2DF. (auth)

29829 (IFA-FR-51) NEUTRON TRANSPORT THEORY. II. BIBLIOGRAPHY AND SUBJECT INDEX. Rosescu, Teodor (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). Aug. 31, 1966. 58p. Dep.

References (440) to literature on neutron transport theory are presented. A subject index is included. (D.C.W.)

29830 (JAERI-1127) THE KAK PROGRAM FOR THE NUMERICAL SOLUTION OF FEW-GROUP NEUTRON DIFFUSION EQUATIONS IN TWO DIMENSIONS. Akanuma, Makoto; Kuge, Yasushi; Yasukawa, Shigeru (Japan Atomic Energy Research Inst., Tokyo). June 1966. 28p. Dep.

The KAK program for the IBM 7044 is capable of solving neutron diffusion problems in cylindrical or slab geometry for one to four groups. Up to 1500 mesh points may be used. The diffusion difference equation is solved by the matrix factorization method. The source iteration is extrapolated by the Tchebysheff polynomial method. The criticality search by the poison control, the adjoint flux calculation, and the perturbation calculation may be performed at the user's option. Normalization of fluxes to an arbitrary input power is allowed. The regionwise-average neutron fluxes and leakages are listed as the output data. A typical running time is 18 min for the case with 530 mesh points and three energy groups which converged with three source iterations. (auth)

29831 (MIT-2344-08) THE MEASUREMENT OF REACTOR PARAMETERS IN SLIGHTLY ENRICHED URANIUM, HEAVY WATER MODERATED MINIATURE LATTICES. Sefchovich, E.; Kaplan, I.; Thompson, T. J. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Oct. 1966. Contract AT(30-1)-2344. 204p. (MITNE-76). Dep. CFSTI.

Reactor physics parameters were measured in six heavy-water lattices which were miniature versions of lattices investigated extensively in the exponential assembly at M.I.T. The lattices consisted of 0.25-inch-diameter rods in two ^{235}U concentrations, 1.143 and 1.027%, and three spacings, 1.25, 1.75, and 2.50 in. The following quantities were measured in each lattice: the ratio of epicadmium to subcadmium capture rates in ^{238}U (ρ_{28}); the ratio of epicadmium to subcadmium fission rates in ^{235}U (δ_{25}); the ratio of the total capture rate in ^{238}U to the total fission rate in ^{235}U (C*); the ^{238}U-to-^{235}U fission ratio (δ_{28}); the intracellular distribution of the activity of bare and cadmium-covered gold foils; and the axial and radial activity distributions of bare and cadmium-covered gold foils. Corrections derived from theory had to be applied to account for the presence of source neutrons and boundary effects. The age-diffusion model developed by Peak was improved and corrections were obtained to extrapolate the miniature lattice data to exponential, critical, and infinite assemblies. To test the validity of the extrapolation methods, the results obtained by extrapolating the miniature lattice data to exponential assemblies were compared with the results of measurements made in the exponential assembly at M.I.T. The extrapolated and measured results agreed generally within the experimental error. It is shown that to extrapolate the values of ρ_{28}, δ_{25}, and C* measured in the miniature lattice to larger assemblies, it is only necessary to describe theoretically the measured spatial distribution of the cadmium ratio of gold. The experimental determination of the material buckling in miniature lattices was investigated. It is apparent that the inclusion of transport effects may be necessary, first, to define the material buckling and, second, to obtain its value. The correction factors for ρ_{28}, δ_{25}, and C* were shown to depend on k_∞ so that k_∞ cannot be determined directly from measurements in the miniature lattice. An iterative procedure was developed to determine k_∞ which converges rapidly and, for the lattices investigated, led to results that were in agreement with the values of k_∞ obtained from measurements in the exponential assembly at M.I.T. (auth)

29832 (MIT-2344-09) HEAVY WATER LATTICE PROJECT ANNUAL REPORT, SEPTEMBER 30, 1966. Thompson, T. J.; Kaplan, I.; Driscoll, M. J. (eds.) (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Contract AT(30-1)-2344. 202p. (MITNE-79). Dep. CFSTI.

An experimental and theoretical program on the physics of heavy water moderated, slightly enriched lattices is being conducted at the Massachusetts Institute of Technology. During the past year, work was completed on studies of fast neutron distributions, lattices with added neutron absorbers, miniature lattices, two-region lattices, pulsed neutron-source methods, and single-rod experiments. Measurements were also completed on six lattices: three spacings each for 0.75-in.- and 0.387-in.-dia, 0.947% enriched, uranium metal fuel. (auth)

29833 (NAA-SR-12271) NEUTRON CROSS SECTIONS FOR ^{238}Pu, ^{242}Pu, AND ^{244}Cm. Dunford, C. L.; Alter, H. (Atomics International, Canoga Park, Calif.). May 1, 1967. Contract AT-(04-3)-701. 142p. Dep. CFSTI.

Evaluated neutron cross section data for the nuclides ^{238}Pu, ^{242}Pu, and ^{244}Cm were prepared for ENDF/B. Because of the lack of experimental data, much of the information contained in these libraries is based on theoretical calculations. All experimental data available through December 31, 1966 was included in the evaluation. A complete set of neutron cross section data was prepared for each nuclide for incident neutron energies between 10^{-3} and 1.5×10^7 eV. These data in the ENDF/B format are available from the Cross Section Evaluation Center at Brookhaven National Laboratory. (auth)

29834 (NP-16703) RAPPORT SUR LA COMPARAISON INTERNATIONALE DE LA MESURE DU TAUX D'EMISSION DE LA SOURCE DE NEUTRONS Ra-Be (α,n) DU CONSEIL NATIONAL DE RECHERCHES NO. 200-1 PAR LA METHODE DE RALENTISSEMENT DES NEUTRONS DANS UNE SOLUTION DE SULFATE DE MANGANESE. (Report on the International Comparison of Measurement of the Emission Rate of the Conseil National de Recherches No. 200-1 Ra-Be Neutron Source by Neutron Moderation in a Manganese Sulfate Solution). Naggiar, V. (Bureau International des Poids et Mesures, Sevres (France)). Feb. 27, 1967. 50p. (In French). Dep.

A comparative analysis is given of the measurements of the emission rates of the No. 200-1 Ra-Be neutron source made between Jan. 1962 and March 1965 by various laboratories. The methods used by the various laboratories are outlined, and the corrections necessary for each method are given. The errors in each method are determined. The results are shown in tables and by graphs. (J.S.R.)

29835 (RT/FI-(66)44) TRANSPORT EQUIVALENT NEUTRON DIFFUSION IN VOID REGIONS. APPLICATION OF A DIFFUSION CODE TO A CORE CONTAINING NOT-HOMOGENIZED CYLINDRICAL CAVITIES. Michelini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 49p. Dep.

A formalism for calculating the effects of large cylindrical cavities in a reactor core is outlined, and results obtained using the formalism are compared with measurements made in the zero-power reactor RITMO. A general formulation of the diffusion coefficient is derived from transport theory, and a formula is obtained for the diffusion coefficient in cylindrical cavities. (D.C.W.)

29836 (SC-RR-66-150) INSTRUCTIONS FOR USING THE CRAM COMPUTER CODE. Watkins, Charles (Sandia Corp., Albuquerque, N. Mex.); Kelleher, Dermond (New Mexico Univ., Albuquerque). May 1967. Contract AT(29-1)-789. 36p. Dep. CFSTI.

Instructions are given for using the CRAM code, a computer program designed to solve multigroup diffusion equations in one and two dimensions. The system of interest is divided into a number of homogeneous mesh regions, and the equations are solved by finite difference techniques. (S.F.L.)

29837 (UJV-1721) VYPOCET SPEKTER TEPELNYCH NEUTRONU V HETEROGENNI MRIZI. (Problems of Thermal Neutron Spectra in a Heterogeneous Lattice). Hron, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1967. 14p. (In Czech). Dep.

A short analysis of various methods for the calculation of thermal neutron spectra and their estimation is presented. A numerical method of solution of the transport equation in a heterogeneous lattice, which is based on a first flight collision probability theory, is used. Some results of calculations for slab systems are shown. (auth)

29838 (WANL-TME-1577) ETC: A FORTRAN IV PROGRAM FOR COMPUTING THE MULTIGROUP P(0) AND P(1) ELASTIC TRANSFER COEFFICIENTS. Gibson, Gordon; Miller, Marian (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb. 1967. Contract SNP-1. 104p. Dep. CFSTI.

A description is given of the ETC program, written in FORTRAN IV, for calculating flux-averaged elements of the multigroup P(0) and P(1) transfer matrices. The same quantities are calculated with ETC as are calculated with the DOODLES program, and also with other programs. However, in deriving the equations for ETC, rather than carrying out a double integration numerically one of

the integrations was carried out analytically. Therefore, the numerical integration need only be carried out over one variable, which results in a more satisfactory numerical treatment and faster calculation. (S.F.L.)

29839 (WAPD-TM-678) PDQ-7 REFERENCE MANUAL. Cadwell, W. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 87p. Dep. CFSTI.

The PDQ-7 program solves the neutron diffusion-depletion problem in one, two, and three dimensions on the CDC 6600 computer. Up to five lethargy groups are permitted, with the thermal neutrons represented by a single group or a pair of overlapping groups. Adjoint and boundary value calculations may be performed, and the depletion may be by point or block. The geometries available are rectangular, cylindrical, spherical, and hexagonal. (auth)

29840 INFLUENCE OF THE CHEMICAL BINDING ON NEUTRON CROSS SECTION FOR COHERENT SCATTERING. Drittler, K. Atomkernenergie, 12: 93-5(Mar.-Apr. 1967). (In German).

Using the formalism of van Hove it is shown that under certain conditions the cross section for coherent scattering is equal to that of incoherent approximation multiplied with a factor. Only at higher neutron energies can this factor be dropped. For other special cases further investigations have to be done. Then, the formalism developed can be used. (auth)

29841 ANGLE-SPACE SYNTHESIS: AN APPROACH TO TRANSPORT APPROXIMATIONS. Kaplan, S.; Davis, J. A.; Natelson, M. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 28: 364-75(June 1967). (WAPD-T-1891).

A method is proposed for solving the transport equation in which the angular dependence is treated by expansion in specially tailored trial functions. The working equations of the method are derived and simple numerical examples presented. (auth)

29842 MULTITABLE TREATMENTS OF ANISOTROPIC SCATTERING IN S/sub N/ MULTIGROUP TRANSPORT CALCULATIONS. Bell, G. I.; Hansen, G. E.; Sandmeier, H. A. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 28: 376-83 (June 1967). (LA-DC-8109).

Much theoretical work has been done in the past to represent the angular dependence in the scattering source term of the Boltzmann equation by means of Legendre or other series expansions. However, relatively little work has been done to feed this information into our present-day S_N codes. The S_N transport codes at LASL allow a representation of anisotropy in the scattering source term by means of multi-table cross-section sets and two formalisms are given to generate these sets. Both involve the expansion of scattering cross sections in a series of Legendre polynomials, and incorporation of the expansion coefficients in the tables of transfer cross sections. One, called a consistent P approximation, involves a simple truncation of the series; while the other, called an extended transport approximation, includes an attempt to approximate the next higher term in the series. A general expression is derived for the error in the neutron flux due to either approximation. The numerical evaluation of S_N cross-section entries for these formalisms has been computerized. Convergence with respect to number of tables is numerically investigated for several different neutron-transport problems: deep penetration of high-energy neutrons in air; critical size of an enriched-uranium bare sphere; reflector savings for an enriched-uranium sphere immersed in H_2O; and fast-reactor core mockup on ANL's ZPR-III. It is concluded from these problems that both approximations converge rapidly with increasing number of tables and that the simple transport approximation gives quite accurate results for a wide range of problems. (auth)

29843 SUMMATION SCHEME FOR CERTAIN SERIES IN NEUTRON THERMALIZATION. Virjo, A. A. (Technical Univ. of Helsinki, Otaniemi, Finland). Nucl. Sci. Eng., 28: 462-3(June 1967).

In neutron thermalization problems, especially with heavy-gas scattering kernels, it is often necessary to sum a series of the form $f(\epsilon) = \sum_{n=0}^{\infty} f_n \chi_n(\epsilon)$, in which the functions $\chi_n(\epsilon)$ are the eigenfunctions of the heavy-gas thermalization operator, and the variable ϵ is the energy of the neutron in units of kT, where T is the moderator temperature. A technique is presented for obtaining the required sum. (S.F.L.)

29844 EXTRAPOLATION DISTANCE IN WATER FOR SMALL GEOMETRY. Swanson, V. A.; DeJuren, J. A. (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 28: 461-2(June 1967).

Accurate values of the extrapolation distance ϵ (the distance from the boundary to the extrapolated endpoint of the appropriate function fitting the geometric buckling) are required to analyze the neutron decay constants as a function of buckling in pulsed decay experiments in water. Values of ϵ were obtained for a water cylinder by measuring flux distributions with Al–Dy foils. (S.F.L.)

29845 CORRELATION OF THE ENERGY OF SINGLE-NEUTRON RESONANCES DETERMINED BY TIME-OF-FLIGHT METHODS. Wynchank, S. A. R.; Havens, W. W. Jr. (Columbia Univ., New York). Nucl. Sci. Eng., 28: 458-61(June 1967).

A brief description is given of how to correlate neutron resonance energy values determined by time-of-flight methods when a simple systematic difference occurs. The factors that offset the energy determination for the measurement of cross sections by time-of-flight are also discussed. (S.F.L.)

29846 ON A MULTIGROUP MONTE CARLO PROGRAM FOR THE CALCULATION OF THE STATIONARY NEUTRON DISTRIBUTION IN HETEROGENEOUS LATTICES. Lahann, H.-J.; Mertins, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 12: 84-92(Mar.-Apr. 1967). (In German).

The multigroup Monte Carlo program MEGMOC is designed to obtain directly the reaction and absorption rates and the path lengths of neutrons for all regions and energy groups in a two-dimensional periodical arrangement. From these the fluxes and other derived quantities are computed. The basic unit of the periodical structure, the macrocell, is composed of rectangular or hexagonal microcells, which have an inner structure with regions of concentric circles and an outer region according to their homogeneous material compositions. The program can also be used for pure cylindrical cells and for finite arrangements, due to special boundary conditions for the macrocell. The migration of neutrons is based on the usual multigroup model, described by the multigroup transport equation, first with isotropic and later with linear anisotropic scattering in the laboratory system. Variance reduction with splitting and Russian roulette is possible. The program is written in Fortran and partly in Compass for the CDC 3400. The number of energy groups, materials, regions, etc. can be freely chosen within the restrictions of the store capacity. (auth)

29847 AN APPROXIMATE THEORY FOR THE SLOWING DOWN OF NEUTRONS IN A NONMULTIPLYING MEDIUM. Kaper, H. G. (Groningen Univ., Netherlands). Nucl. Sci. Eng., 28: 415-25(June 1967).

An approximate theory for the slowing down of neutrons in a nonmultiplying medium with plane symmetry is described. The theory is based on an approximate form of the transfer function for elastic scattering under the hypothesis that the mass number of the moderator is larger than one. In the A^{-n} approximation the slowing down equation is reduced to a finite system of differential equations with respect to the lethargy variable. A detailed study was made of the results obtained in the A^{-n} approximation with $N = 0$ and $N = 1$. Special attention was given to a comparison of the A^{-1} approximation with age theory and asymptotic theory. (auth)

29848 PROPOSAL ON DATA TREATMENT IN THE FEYNMAN-α EXPERIMENT. Furuhashi, Akira; Izumi, Sigeru (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 4: 99-101(Feb. 1967).

The standard procedure for data treatment in the Feynman-α experiment is to examine the variance-to-mean ratio of the number of counts c in a certain time interval T, and to observe the deviation thereof from unity. The traditional index Y which represents the non-Poissonian nature of the counting is given by $[\overline{c^2} - (\overline{c})^2]/\overline{c} = 1 + Y$. Because the index Y has certain shortcomings, another index Z based upon the formula $(\overline{c^2} - \overline{c})/(\overline{c})^2 = 1 + Z$ is proposed. In contrast to the traditional Y, the newly proposed Z serves better in representing the non-Poissonian nature of the neutron field. (S.F.L.)

29849 SPIN PRECESSION DURING INTERFEROMETRY OF FERMIONS AND THE PHASE FACTOR ASSOCIATED WITH ROTATIONS THROUGH 2π RADIANS. Bernstein, Herbert J. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 18: 1102-3 (June 12, 1967).

A proposed experiment which combines spin precession and two-slit interferometry of unpolarized neutrons is analyzed. The analysis elucidates the connection with a possible observation of the phase factor (–1) associated with the rotation of a half-integral spin particle through 2π radians. (auth)

29850 FUNDAMENTAL RESEARCH IN NUCLEAR RESEARCH CENTRES. Neel, Louis (CEN, Grenoble, France). At. Energy Rev., 4: Commemorative Issue, 23-9(Dec. 1966).

It is recalled that fundamental research, in the past rather modest in its demands, today requires considerable human and material resources. Because of the substantial resources at their disposal, the nuclear research centers are the organizations best equipped for fundamental and applied research in the

atomic energy field. Among the areas of research in which the nuclear research centers play a role of prime importance, nuclear physics and chemistry (particularly plasma physics and fusion), neutron diffraction (with special reference to cold neutrons of large wavelength), the effects of radiation on solids, and electronics are mentioned. It is believed that nuclear research centers, for reasons of safety and economy, are in the best position of all organizations engaged in nuclear research to manage the operation of reactors, particularly research reactors. Finally, the positive results which have emerged from close collaboration between the nuclear research centers, the universities and industry are stressed. (auth)

29851 CAVITY BOUNDARY CONDITIONS FOR THE NEUTRON FLUX DENSITY WITH DEVIATIONS FROM LAMBERT'S LAW. Holder, P.; Emendoerfer, D. (Technische Hochschule, Stuttgart). Nukleonik, 9: 285-8(Apr. 1967).

Boundary conditions with deviations from Lambert's law are given for a finite cylindrical cavity between core and upper reflector in a completely reflected reactor. Neutron diffusion in core and reflector is calculated according to the diffusion theory in (r,z)-geometry. Neutron streaming in the cavity is taken into account by the free flight of neutrons. As an application the neutron flux distribution and reactivity of the gas-cooled high-temperature pebble-bed reactor are calculated for different core heights and reflector positions. (auth)

29852 CONVERGENCY OF THE SPHERICAL HARMONICS METHOD AND ITS CONNECTION WITH THE NORMAL MODE APPROACH. Nonnenmacher, Th. F. (Technische Hochschule, Karlsruhe, Ger.). Atomkernenergie, 12: 183-8(May-June 1967).

The connection between the spherical harmonics method and the normal mode approach is pointed out. It is proved that, in the sense of distribution theory, the partial solutions of the spherical harmonics method converge to the complete set of eigenfunctions given by K. M. Case. The truncated Legendre polynomial expansion of Case-eigendistributions represents the result of a P_L-approximation. (auth)

29853 INITIAL VALUE PROBLEM FOR THE NEUTRON THERMALIZATION. Mika, Janusz (Inst. of Nuclear Research, Swierk, Poland). Nukleonik, 9: 303-4(Apr. 1967).

It is shown that the initial-value problem for time-dependent neutron thermalization formulated by Bednarz [Proceedings of Symposium on Pulsed Neutron Research, Karlsruhe, May 10–14: 259(1965)] has a unique solution. The free-gas kernel considered by Albertoni and Montagnini [J. Math. Anal. Appl. 13: 19(1966)] is automatically included. (S.F.L.)

29854 EXTRAPOLATION DISTANCE FOR MONOENERGETIC NEUTRONS, AN EXACT CALCULATION. Erdmann, R. C. (Univ. of California, Los Angeles); Shapiro, J. L. Nukleonik, 9: 302-3(Apr. 1967).

The normal-mode expansion method was used to find the extrapolated end point for monoenergetic neutrons in a finite slab for all thicknesses. Some of the results are applicable to the spherical model. (S.F.L.)

29855 THEORETICAL DETERMINATION OF FAST NEUTRON SPECTRA FOR A NUCLEAR REACTOR IN COMBINED LAYERS OF WATER AND ALUMINUM. Imam, M. (Christian-Albrechts-Univ., Kiel). Atomkernenergie, 12: 35-42(Jan.-Feb. 1967).

Knowledge of the detailed variation of the high-energy flux in nuclear reactors (energy range from 0.0005 MeV to 10 MeV) is important for the study of certain problems in reactor physics, for instance radiation damage. The fast neutron spectra of the research reactor in Geesthacht, FRG, were calculated by means of the group-diffusion theory, where the energy range from 0.0005 to 10 MeV was divided into 16 energy groups. The spectrum obtained was compared with earlier calculated spectrum of FRG with the transport theory and were found to be in good agreement with each other. (auth)

29856 CALCULATION OF NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS. Poehlandt, K.; Wasserroth, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Atomkernenergie, 12: 55-8(Jan.-Feb. 1967). (In German).

A new method is presented to determine the energy dependence of neutron fluxes from activation measurements. For this purpose it is assumed that an unnormalized approximation of the relative energy distribution of the neutrons exists. It is not possible to calculate the real flux $\varphi(E)$ by means of activation, therefore the real flux will be approximated by the function $\varphi_N(E)$ due to the following condition: $\int_0^\infty \{[\varphi_N(E) - \varphi(E)]/\varphi(E)\}^2\, dE$ = minimum. This condition distinguishes the new method from the others used so far. It is shown that the calculation can be carried out if a suitable function is used to correct the zero energy distribution. This function has to be an othonormal expansion of the "sensitivity functions." These sensitivity functions are defined. The theoretical basis of this method is discussed and the resulting equations are illustrated by an example. (auth)

29857 TIME-DEPENDENT NEUTRON THERMALIZATION BY MONTE CARLO METHOD. Cupini, E. (Comitato Nazionale Energia Nucleare, Bologna); Molinari, V. G.; Solinas, G. Nukleonik, 9: 295-300(Apr. 1967).

The Monte Carlo method is applied to study the approach to equilibrium of a neutron pulse in homogeneous spheres as well as in an infinite medium. The free-gas mass-1 scattering kernel is used to emphasize the most relevant properties of neutron thermalization in finite moderating systems, generally studied in the frame of the diffusion theory. The time dependence of the neutron spectrum, total neutron density, and spatial neutron distribution, following a neutron burst at t = 0, are obtained. The results for an infinite medium are in agreement with other numerical calculations. It is shown that, if the radius of the sphere is sufficiently small (≤0.9 cm), the total neutron density does not exhibit an exponential decay and a steady-state spectrum is not achieved. The peculiar behavior of the very small samples is connected with the nonexistence of discrete eigenvalues. (auth)

29858 STANDARD FISSION NEUTRON SOURCE. Kooi, J.; Mijnheer, B. J.; Aten, A. H. W. (Inst. for Nuclear Physics, Amsterdam). Int. J. Appl. Radiat. Isotop., 18: 439-40(June 1967).

The preparation of a source containing approximately 1 μg of ^{252}Cf is described. The dimensions were the same as those of a standard Ra/Be source (outside diameter 15 mm, height 15 mm), with a weight of about 20g. The absolute neutron emission was found to be $3.596 \pm 0.022 \times 10^8$ n/sec. Measurements were made of the angular dependence of the neutron emission. (UK)

29859 EMPIRICAL METHODS OF CALCULATION OF FAST NEUTRON TRANSIT THROUGH HYDROGEN CONTAINING MEDIUM. Sinitsyn, B. I.; Tsypin, S. G. (Inst. of Physics and Power Engineering, Obninsk, USSR). Jad. Energ., 13: 169-73 (May 1967). (In Czech).

It is shown that in addition to the exact mathematical calculations for neutron passage through media containing hydrogen (the method of moments, Monte-Carlo method, etc.), it is possible to use empirical and semiempirical methods. The use of the "direct forward" approximation for calculating fast neutron passage in hydrogen is analyzed, and the accuracy of the method is estimated. A further development of the empirical method is given using a power dependence of the cross sections derived for calculations for fast neutrons in homogeneous hydrogen-containing media. (R.V.J.)

29860 EXPERIMENTAL INVESTIGATION OF ANGULAR DEPENDENT THERMAL NEUTRON LEAKAGE SPECTRA. Kallfelz, J. M. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 9: 273-81(Apr. 1967).

Using the pulsed-source–chopper technique, asymptotic angular dependent neutron leakage spectra were measured. The spectra for perpendicular leakage from quasi-infinite samples of H_2O, benzene, and Dowtherm A are practically the same. These spectra and diffusion-cooled spectra from thin slabs of H_2O and benzene are well described by results of the program ADALS, using realistic scattering kernels. The measured angular dependence of leakage spectra from quasi-infinite samples of H_2O and plexiglass, which correspond to those of the Milne problem, is relatively weak. The average neutron energy for perpendicular leakage from H_2O is about 19% higher than that of a Maxwellian at moderator temperature, E_M, while for emission parallel to the surface, the average energy is still about 10% higher than E_M. This weak angular dependence is in agreement with the results of the program IMALS, using the Goldman–Nelkin scattering kernel. (auth)

29861 POLYARIZOVANNYE MEDLENNYE NEITRONY. (Polarized Slow Neutrons). Abov, Yu. G.; Gul'ko, A. D.; Krupchitskii, P. A. Moscow, Atomizdat, 1966. 267p.

The experimental methods used for the polarization of thermal neutrons; methods for the measurement of the degree of polarization; and methods for the measurement of the interaction of polarized neutrons with nuclei, atoms, and crystals are described. The material included can be used in the selection of methods for the production and analysis of polarized beams, in the construction of beam sources, and in the calculation of beam characteristics. (tr-auth)

29862 MEASUREMENT BY THE PULSE METHOD OF THE DEVIATION OF THE NEUTRON SPECTRUM FROM THE EQUILIBRIUM MAXWELL SPECTRUM FOR WATER SAMPLES OF FINITE DIMENSIONS. Stepanov, S. B. At. Energ. (USSR), 22: 131-2(Feb. 1967). (In Russian).

The pulse method was used to measure the deviation of the

neutron spectrum from the equilibrium Maxwell spectrum for water samples at 20°C in cylindrical vessels of diameter 30 cm at different water levels of 3.25, 4.5, and 7.00 cm. The results obtained are tabulated and show the great precision that is attainable with the pulse method. (J.S.R.)

29863 CALCULATION OF THE PASSAGE OF FAST NEUTRONS THROUGH GRAPHITE. Shirkin, L. M. At. Energ. (USSR), 22: 97-100(Feb. 1967). (In Russian).

The results of the calculation by the Monte Carlo method of the passage through graphite of neutrons from a dense monodirectional source with $E_0 = 3.3$ and 8.0 MeV were reported. The angle of incidence of the neutrons was 0°. Graphite films with thicknesses of 0.9 to 6 times the mean free path length were examined. The dose, energy, and numerical albedo for the graphite and the angular and energy distribution of the reflected neutrons were found. The angular distribution of the energy of the scattered neutrons was calculated. The effect of the mean cosine of the scattering angle on the size of the albedo and on the value of the constants of the angular distribution was examined. The data obtained can be used for shielding calculations. (tr-auth)

29864 MODEL OF A HEAVY MODERATOR AND SOLUTION OF THE PROBLEM OF THE THEORY OF THE THERMALIZATION OF NEUTRONS IN AN ANALYTICAL FORM. Kazarnovskii, M. V. At. Energ. (USSR), 22: 100-7(Feb. 1967). (In Russian).

A model of neutron scattering in heavy moderators is proposed. The model contains three arbitrary functions of neutron velocity which can be derived from the conditions of the best approximations of the actual scattering nucleus. For this model, within the framework of the scattering approximation, the neutron distribution function is found in the integral form for the general case of random sources. The eigenvalues and eigenfunctions of equations of neutron transport are examined. (tr-auth)

29865 METHOD FOR THE CALCULATION OF THE SPACE-ENERGY DISTRIBUTION OF THERMAL NEUTRONS IN HETEROGENEOUS REACTORS. Fedulov, M. V. At. Energ. (USSR), 22: 108-13(Feb. 1967). (In Russian).

A method for the determination of the space-energy distribution of thermal neutrons in heterogeneous reactors is proposed. If the effect of the asymmetric portion of the scattering cross section on the change of the neutron energy is neglected, then in a series of cases the problem of the determination of the integral parameter of the nuclei can be reduced to the solution of the monoenergetic kinetic equation for some assembly of energy values with subsequent determination of the energy spectrum of the neutrons. The possibility of using the integration process for making the results of the first approximation more precise is investigated. (tr-auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 29443, 29450, 29565, 29567, 29827, 29885, 29966–29969, 30038, and 30048.

29866 MEASUREMENT OF THE PARAMETERS P, D, R, AND R' IN PROTON–DEUTERON ELASTIC SCATTERING AT 135 MeV. Poulet, M.; Michalowicz, A.; Kuroda, K.; Cronenberger, D. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., A99: 442-56(1967). (In French).

Using a polarized proton beam and a deuterium liquid target, the parameters $P(\theta)$, $D(\theta)$, $R(\theta)$ and $R'(\theta)$ in p-d elastic scattering at 135 MeV were measured in the 19 to 58° cms angular range. The experimental set-up and the way in which the data were measured are described. Results are compared with theoretical calculations using the impulse approximation and nucleon-nucleon amplitudes. (auth)

29867 ON THE SCATTERING OF NEUTRONS BY $_1{}^3$H AND $_2{}^3$He NUCLEI. Drigo, L.; Moschini, G.; Villi, C. (Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim. (10), 49B: 227-32(June 11, 1967).

Some critical aspects involved in the analysis of unpolarized neutron data are emphasized. The four-nucleon processes: $n + {}^3H \rightarrow {}^3H + n$, $n + {}^3He \rightarrow {}^3He + n$, and $n + {}^3He \rightarrow {}^3H + p$ are examined. It is concluded that lack of experimental knowledge prevents one from testing the internal consistency of the available data concerning the processes under consideration. This implies that adjusted data should be taken with caution. (J.F.P.)

29868 ABSORPTION OF π^- MESONS AND γ RAYS AND NUCLEON CORRELATION IN ^{4}He. Kopaleishvili, T. I.; Machabeli, I. Z. (Tbilisi State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 511-20(Mar. 1966). (In Russian).

The ^{4}He(π^-,nn) and ^{4}He(γ,np) were investigated using ^{4}He wave functions determined from the variational problem. One of these functions corresponds to the nucleon-nucleon interaction potential with a repulsive core, while the other corresponds to the velocity dependent potential. The interaction between the ejected nucleons is also taken into account. The (γ,p) and (γ,n) and (π^-,n) reactions are also investigated from the standpoint of determining whether the binding energy, nuclear size of ^{4}He and such characteristics of the (π^-,n) and (γ,np) as the location of the maximum in the $\delta(E_\gamma)$ curve can be explained simultaneously by the same form of the potential. It is concluded that the wave function corresponding to the velocity-dependent potential, in addition to yielding acceptable values for the size and binding energy of the ^{4}He nucleus, also satisfactorily describes the (γ,np), (γ,n), (π^-,nn) and (π^-,n) processes. (L.B.S.)

29869 STRUCTURE OF THE α PARTICLE FROM ELASTIC PROTON SCATTERING. Bassel, R. H.; Wilkin, C. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 871-3(May 15, 1967). (BNL-11274).

The Glauber model is used to determine alpha particle structure from elastic proton scattering. Differential cross sections are shown for this scattering and compared with experimental results. (J.F.P.)

29870 DETECTION OF THE SINGLET DEUTERON (d) AND THE REACTION ^{9}Be(p,d)^{8}Be. Cohen, B. L.; May, E. C.; O'Keefe, T. M. (Univ. of Pittsburgh). Phys. Rev. Lett., 18: 962-5 (May 29, 1967).

The reaction ^{9}Be(p,pn)^{8}Be is studied by detecting the outgoing neutron and proton in coincidence while measuring the proton energy by the pulse height in a solid-state detector and the neutron energy by the time delay between arrival of the neutron in an organic scintillator. In some fraction of these reactions the actual reaction is (p,d), and it is these which are of interest. The energy distributions of protons, detected in coincidence with neutrons from breakup of singlet deuterons, and angular distributions of d and d are shown. (J.F.P.)

29871 d–α DOUBLE SCATTERING. Bernstein, E. M. (Los Alamos Scientific Lab., New Mex.); Ohlsen, G. G.; Starkovich, V. S.; Simon, W. G. Phys. Rev. Lett., 18: 966-8(May 29, 1967). (LA-DC-8777).

Azimuthal asymmetries produced in d–α double scattering were measured at ten second-scattering angles. Both scatterings take place at the same center-of-mass energy. Published sets of phase shifts are inconsistent with the present measurements. It was demonstrated that α–d scatterings can be used to produce a deuteron beam with useful vector polarization at energies near 10 MeV. (auth)

29872 NEW METHOD FOR MEASURING THE RATIO OF THE PROTON MAGNETIC MOMENT TO THE NUCLEAR MAGNETON. Marion, J. B.; Winkler, H. (California Inst. of Tech., Pasadena). Phys. Rev., 156: 1062-4(Apr. 20, 1967).

Proton nuclear reaction energy measurements with magnetic and with time-of-flight beam analyzers can be combined to obtain a value for the proton magnetic moment, measured in nuclear magnetons. The value derived from experiments already performed is $\mu_p/\mu_n = 2.79259$ with a precision of ±44 ppm (without diamagnetic correction for protons in water). An increase in precision to ±20 ppm should be possible with equipment presently available. (auth)

29873 NUCLEAR PHOTODISINTEGRATION IN THE 1s SHELL: A PERTURBATIVE APPROACH TO THE DIPOLE SUM RULES. Davey, P. O. (State Univ. Coll., Fredonia, N. Y.); Valk, H. S. Phys. Rev., 156: 1039-61(Apr. 20, 1967).

The integrated and bremsstrahlung-weighted E1 photoabsorption cross sections, σ_{int} and σ_b, were calculated for the lightest nuclei, ^{2}H, ^{3}H, ^{3}He, and ^{4}He, within the framework of a second-order perturbation procedure. For the purpose of comparison, two Gaussian nucleon–nucleon potentials were employed: one containing a repulsive core and central attractive and tensor components, the other only central attractive and tensor components. The results for σ_{int} indicate that while reasonable over-all agreement with experiment may be achieved with either potential, the component contributions differ widely because of the admixture of the repulsive core. Furthermore, the results for σ_b for the deuteron seem to indicate a deficiency in the present choice of oscillator basis functions when applied to the loosely bound system. Considerable improvement for σ_b is noted for ^{3}H, ^{3}He, and ^{4}He, where the nuclei are more tightly bound and less extended structures. It is found by analyzing exact and approximate third-order contributions to both the deuteron binding energy and integrated cross section that the use of a wave function containing parameters determined by minimization of the perturbation expansion through second order is probably not acceptable, at least for this nucleus.

This is further substantiated by comparison with the binding-energy results obtained from an exact numerical solution of the coupled S and D radial differential equations. (auth)

29874 BACKWARD DEUTERON ELECTRODISINTEGRATION AT LOW ENERGIES. Napolitano, E.; Ponzano, G.; Reineri, M. T. (Univ., Turin). Nuovo Cim. (10), 48B: 432-6(Apr. 11, 1967).

Theoretical techniques are refined for treating the e + d → e′ + n + p reaction at low energies. Tensor forces are taken into account in the initial and final states, treating the n-p system non-relativistically. Multipole amplitudes up to E2 were calculated. The contribution from higher multipoles was evaluated within the approximation of vanishing n-p interaction in the corresponding final states. The investigation is restricted to backward scattering of the electrons. (S.F.L.)

29875 BREMSSTRAHLUNG PRODUCTION IN p-p COLLISIONS AT 30 MeV. Thompson, J. C. (Univ. of Manitoba, Winnipeg); Naqvi, S. I. H.; Warner, R. E. Phys. Rev., 156: 1156-8(Apr. 20, 1967).

The proton-proton bremsstrahlung production cross section was measured at 30-MeV incident proton energy and at 35° in the Harvard geometry. Using the same assumptions about the dependence of the cross section on noncoplanarity as were made in previous work at low energies, a value of 1.85 $\mu b/sr^2$ is obtained, with a statistical error of 0.25 $\mu b/sr^2$ and a total error estimated to place an upper limit of about 4 $\mu b/sr^2$ on the cross section. This upper limit disagrees with Signell and Marker's prediction of about 15 $\mu b/sr^2$. (auth)

29876 Λ-p SCATTERING AND THE Λ-N INTERACTION. Ali, S.; Grypeos, M. E.; Kok, L. P. (International Centre for Theoretical Physics, Italy). Phys. Lett., 24B: 543-7(May 29, 1967).

Using the effective range approximation, an analysis is made of the available Λ-p scattering data using Yukawa Λ-N interactions, including the purely attractive potentials as well as those with a hard core. The analysis indicates the appropriateness of a value of the intrinsic range of the Λ-N interaction, approximately that suggested by the one-boson exchange model (boson mass ≳ 400 MeV). Singlet and triplet Λ-N potentials are also derived and are discussed. (auth)

29877 THE INSENSITIVITY OF THE γ(d,n)p CROSS SECTIONS TO REALISTIC POTENTIALS. Mukherjee, S. N. (Banaras Hindu Univ., Varanasi, India); Roy, B. Barman; Rustgi, M. L. Phys. Lett., 24B: 548-9(May 29, 1967).

Employing the Yale and Hamada-Johnston potentials, the bremsstrahlung-weighted and integrated cross sections were evaluated for the photodisintegration of the deuteron; the results were found to be quite insensitive to the details of these potentials. (auth)

29878 THE NEUTRON–DEUTERON SCATTERING LENGTHS. van Oers, W. T. H. (Univ. of California, Los Angeles); Seagrave, J. D. Contracts W-7405-eng-36; Nonr 233-(44). Phys. Lett., 24B: 562-5(May 29, 1967). (LA-DC-8311).

New data on coherent and incoherent neutron–deuteron scattering permit re-evaluation of the doublet and quartet scattering lengths, with the results $^4\alpha = 6.14 \pm 0.06$ fm, and $^2\alpha = 0.11 \pm 0.07$ fm. These values imply $\sigma_{free} = 3.14 \pm 0.06$ b. A comparison was made with the values obtained from extrapolations of the ^4S and ^2S phase shifts for n-d and p-d elastic scattering. For the n-d ^2S phase shifts it is found that the effective range expansion has a pole at a negative energy ($E_{lab} \simeq -0.1$ MeV). (auth)

29879 SKHEMY RASPADA RADIOAKTIVNYKH YADER. A < 100. (Decay Schemes of Radioactive Nuclei. A < 100). Dzhelopov, B. S.; Peker, L. K. Moscow and Leningrad, Izdatel'stvo Nauka, 1966. 749p.

Systematic experimental data are given on the properties of nuclei from A = 1 to 99, and newly constructed decay schemes are presented. The data include information on the levels in the excitation processes of radioactive decay and in various nuclear reactions (Coulomb excitation, (n,γ), (d,p), (p,p), etc.). Extensive references are included. (R.V.J.)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 29443, 29827, 29879, 29913, 29930, 29941, 29942, 29966–29969, 30020, 30021, 30042, 30056–30058, 30071–30073, 30077, and 30078.

29880 (ANU-P-379) ANNUAL REPORT [ON NUCLEAR PHYSICS], 1966. Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). Jan. 1967. 54p. Dep.

There were two topical reports appended to this progress report. These were separated and cycled as individual masters, see ANU-P-377 and ANU-P-380.

29881 (EUR-3454.e) ELASTIC SCATTERING OF NEUTRONS FROM ^{6}Li. Knitter, H.-H.; Coppola, M. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 1967. 14p. Dep.

Angular distributions of neutrons elastically scattered from ^{6}Li were measured in the energy region between 1.0 and 2.3 MeV using a fast neutron time-of-flight spectrometer. Flux attenuation and shape corrections were calculated. The final data are presented in the form of coefficients of Legendre polynomial expansions. (auth)

29882 (JINR-P1-3305) OBRAZOVANIE LITIYA-8 PRI ZAKHVATE MEDLENNYKH π⁻-MEZONOV YADRAMI UGLERODA AZOTA I KISLORODA. (Lithium-8 Production in Capture of Slow Negative Pions by Carbon, Nitrogen, and Oxygen Nuclei). Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 16p. (In Russian). Dep.

With the help of photoemulsions, two- and three-particle reactions with the production of ^{8}Li and ^{8}B nuclei in the negative pion capture by carbon, nitrogen, and oxygen nuclei were investigated. The relative probabilities w_i of two-particle decays of light nuclei are found to be smaller than 2.10×10^{-16}. The probability of the reaction $\pi^- + {}^{12}C \rightarrow {}^8Li + {}^3He + n$ is obtained to be 2.2×10^{-4}. The reaction $\pi^- + {}^{16}O \rightarrow {}^8Li + {}^7Be + n$ is strongly suppressed. The energy spectra and angular correlations of secondary particles for the reaction $\pi^- + {}^{12}C \rightarrow {}^8Li + {}^3He + n$ are measured. Experimental data indicate the important role, in negative pion capture by light nuclei, of the mechanism of a direct capture of small-nucleon associations in nuclei, which agrees with the theory of direct nuclear reactions. (auth)

29883 (NP-16695) DISTRIBUCIONES ANGULARES DE LOS ESTADO BASE Y PRIMER EXCITADO DE ^{17}O A TRAVES DE REACCIONES (d,p) EN ^{16}O EMPLEANDO DEUTERONES CON ENERGIAS DE 0.74, 0.99, 1.24 Y 1.51 MeV. (Angular Distribution in the Initial Excitation of the Reaction at 0.74, 0.99, 1.24 and 1.51-MeV Deuteron Energies). Salgado, Rafael Almanza (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1963. 49p. (In Spanish). Dep.

Thesis.

The angular distributions of the ground state and first excited level of ^{17}O were measured using the double spectrograph technique. This technique is described in detail, and the experimental procedure is discussed. The results obtained are compared with the theoretical curves calculated using the Born distorted-wave theory, and there is satisfactory agreement for the first excited level for the bombardment with deuterons at 0.74, 1.24, and 1.51 MeV. (J.S.R.)

29884 (NYO-GEN-72-48) THE (p,d) OR (p,pd) REACTIONS FROM PROTON BOMBARDMENT OF ^{6}Li AT 14.7 MeV. Seifert, Aurel Martin (Columbia Univ., New York. Dept. of Physics). 1966. Contract AT(30-1)-72. 80p. Dep. CFSTI.

Thesis.

Relative differential cross sections are presented for the formation of deuterons in the two competing processes from the reactions: ^{6}Li(p,d)^{5}Li and ^{6}Li(p,pd)^{4}He. For the pickup process leading to the ground state of ^{5}Li results are available for laboratory angles from 10 to 60°. The shape of the spectrum clearly favors an l = 1 orbital for the picked-up neutron. The second reaction, which leads to a continuous spectrum, was observed for laboratory angles from 15 to 90°. This continuous spectrum is attributed almost entirely to the very broad 3.82-MeV first excited level of ^{5}Li. Its measured average energy of 3.89 ± 0.10 MeV corresponds to an excited state of ^{5}Li at 3.72 ± 0.10 MeV, with a full width Γ estimated to be 6.3 ± 0.5 MeV. A small "peak" at low energies was attributed to a contribution from the next excited level of ^{5}Li at 16.64 MeV. The integrated relative cross section $d\sigma/d\Omega_{CM}$ (θ) for the latter process seems to exhibit symmetry about 90° in the center-of-mass system, from 60 to 113°, and both processes exhibit absolute maxima at the same forward angles: $\theta_{Lab} = 22.5 \pm 0.5°$. (auth)

29885 ELASTIC SCATTERING OF 1-GeV PROTONS FROM HYDROGEN, HELIUM, CARBON, AND OXYGEN NUCLEI. Palevsky, H. (Brookhaven National Lab., Upton, N. Y.); Friedes, J. L.; Sutter, R. J.; (and others). Phys. Rev. Lett., 18: 1200-4 (June 26, 1967). (BNL-11360).

The differential elastic scattering cross sections of 1-BeV protons on hydrogen, helium, carbon, and oxygen were measured. The nuclear data exhibit diffractionlike structure associated with the multiple scattering of protons by nucleons inside the nuclei. The

experimental technique provides a new and powerful method for studying nucleon-nucleon correlations inside the nucleus. (auth)

29886 FRAGMENTATIONS OF COSMIC-RAY NUCLEI WITHOUT PARTICLE PRODUCTION IN THE ENERGY RANGE (10/1000)GeV/nucl. Rybicki, K. (Inst. for Nuclear Research, Krakow). Nuovo Cim. (10), 49B: 203-6(June 11, 1967).

Some results concerning the special type of interactions of cosmic ray nuclei in nuclear emulsion, namely those in which the primary nucleus breaks up without visible particle production, are presented and discussed. Events are presented in the energy ranges 20, 200 GeV/nucleon, and some TeV/nucleon. (J.F.P.)

29887 PARITIES OF STATES IN ^{35}O AND ^{33}Cl. Mubarakmand, S.; Macefield, B. E. F. (Nuclear Physics Lab., Oxford). Nucl. Phys., A98: 82-96(1967).

The reactions ^{34}N(d,n)^{35}O and ^{32}S(d,n)^{33}Cl were studied. Spins, parities, and relative spectroscopic factors were determined using the neutron time-of-flight technique. DWBA analysis of angular distributions of the neutron groups yields l_p = 1, 1, (0 + 2), and 2 for the ground state and excited states in ^{35}O at 6.16, 6.8 (doublet), and 7.25 MeV respectively and l_p = 2, 0, and 2 for the ground state and excited states in ^{33}Cl at 0.81 and 2.11 MeV, respectively. (auth)

29888 THE (α,n) CROSS SECTIONS ON ^{17}O AND ^{18}O BETWEEN 5 AND 12.5 MeV. Hansen, Luisa F.; Anderson, John D.; McClure, John W.; Pohl, Bertram A.; Stelts, Marion L.; Wesolowski, Jerome J.; Wong, Calvin (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., A98: 25-32(1967). (UCRL-70338).

The excitation functions for the (α,n) reaction on ^{17}O and ^{18}O were measured from 5 to 12 MeV using long counters. Also, the neutron differential cross sections were measured at 9.8, 11.6, and 12.2 MeV, using the Livermore neutron time-of-flight facility. Neutron spectra were obtained every 15° between 3 and 135° with gas targets of enriched ^{17}O and ^{18}O. The angular distributions are roughly symmetric about 90°. Small forward peaking is observed at the higher bombarding energies for some of the states, mainly for the ground and first excited states. (auth)

29889 RADIATIVE CAPTURE OF DEUTERONS IN THE REGION OF THE GIANT RESONANCE IN ^{16}O. Yoccoz, J.; Jang, S. (Centre de Recherches Nucleaires, Strasbourg. Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., A98: 41-53 (1967). (In French).

Radiative capture of deuterons in the giant resonant states in ^{16}O are studied theoretically within the framework of one-particle–one-hole and two-particle–two-hole excitations. The experimental gamma-ray angular distribution, which exhibits an admixture character of dipole and quadrupole transitions, is explained by the competition between direct electric quadrupole transition and semi-direct electric dipole transition for which a Coulomb mixture of two isobaric spin states, T = 0 and T' = 1, is introduced. The calculated total cross-section curves show that the observed radiative dipole capture of deuterons in the giant resonance region is principally due to the isobaric spin impurity of two close dipole states. (auth)

29890 THE DECAY OF THE 8.88 MeV LEVEL IN ^{16}O. Gill, R. D.; Haeusser, O.; Lopes, J. S.; Rose, H. J. (Oxford Univ.). Nucl. Phys., A98: 129-35(1967). (LFEN-64).

The multipole mixing ratios of the de-excitation gamma rays from the 2$^-$, 8.88-MeV level in ^{16}O were investigated. The results were: δ(8.88 → 6.14 MeV) = 2.9 ± 0.2, an E2/M1 mixture; and $|\delta(8.88 \rightarrow 7.12\ \text{MeV})| > 2.5$, also an E2/M1 mixture. These results are compared in both magnitude and phase to the model of Elliott and Flowers. (auth)

29891 SEARCH FOR RESONANT STATES OF $_\Lambda{}^6$Li AND Λ^{3*}Be HYPERNUCLEI. Goodhead, D. T.; Evans, D. A. (Oxford Univ.). Nucl. Phys., B2: 121-34(1967).

A search was made for narrow resonant states of $_\Lambda{}^6$Li and excited $_\Lambda{}^{3*}$Be (T = 1) hypernuclei among a sample of 31 unique and 48 ambiguous $_\Lambda{}^5$He hypernuclei produced by the interaction of stopping K$^-$ mesons in nuclear emulsions. If present, the $_\Lambda{}^6$Li state is expected to show as a narrow resonance at ≲ 1 MeV center-of-mass kinetic energy in the p-$_\Lambda{}^5$He system, and the lowest level of $_\Lambda{}^{3*}$Be as a narrow resonance at about 12 MeV in the α-$_\Lambda{}^5$He system. In each case the experimental data are consistent with no such such resonant state and set conservative upper limits of 25% and 15%, respectively, for the proportion of observed $_\Lambda{}^5$He hypernuclei produced by these final state interactions. (auth)

29892 THE (d,α) REACTION ON ^{13}C AT LOW DEUTERON ENERGIES. Klyucharev, A. P.; Titov, Yu. I. (Kharkov State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 435-8(Mar. 1966). (In Russian).

Measurements were made of angular distributions and cross sections for the ^{13}C(d,α)^{11}B reaction in order to determine the dominant mechanism at this reaction in the range of low deuteron energies. Resonances were observed at 1.14 and 1.48 MeV, which correspond to levels of the compound nucleus at 17.11 and 17.47 MeV, respectively. Comparison of experimental and calculated angular distributions at 1.14, 1.26, and 1.48 MeV indicate that the rise of the cross section in the range of small angles can be attributed to the contribution from the direct process. Expansion of the angular distribution in series of Legendre polynomials allowed certain inferences to be drawn regarding the spins and parities of the compound nucleus. (L.B.S.)

29893 OPTICAL MODEL ANALYSIS OF ELASTIC α PARTICLE SCATTERING. Nemets, O. F.; Rudchik, A. T.; Tokarevskii, V. V. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 444-8(Mar. 1966). (In Russian).

The elastic scattering of 27.2-MeV α particles from ^{12}C, ^{27}Al, Ti, ^{63}Cu, and ^{116}Sn and of 24.7-MeV α particles from ^{27}Al, ^{59}Co, and Cu was analyzed on the basis of the optical model. Optical potential parameters yielding the best fit to the experimental data were obtained. (L.B.S.)

29894 PROBLEM OF DEUTERON THRESHOLD STATES IN LIGHT NUCLEI. Balashov, V. V.; Rotter, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 479-82(Mar. 1966). (In Russian).

The spectra of the deuteron reduced width in the ^{6}Li(^{6}Li,α)^{6}Be and ^{9}Be(^{6}Li,α)^{11}B reactions are calculated in the framework of the shell model with intermediate coupling. In agreement with experiment the principal peak in the spectra is located near the deuteron break-up threshold of 22.3 MeV for ^{8}Be → ^{6}Li + d and 15.8 MeV for ^{11}B → ^{9}Be + d. (L.B.S.)

29895 INVESTIGATION OF THE SENSITIVITY OF SOME NUCLEAR CHARACTERISTICS TO THE PARAMETERS OF THE INTERMEDIATE-COUPLING MODEL. Boyarkina, A. N.; Zhusupov, M. A.; Rotter, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 472-8 (Mar. 1966). (In Russian).

Calculations were made of the dependence of angular correlations, reduced widths, and spectroscopic factors on parameters of the intermediate coupling model for the resonance reactions ^{7}Li + p → ^{8}Be(1$^+$,1), ^{7}Li + p → ^{8}Be(2$^+$), and ^{11}B + p → ^{12}C(2$^+$,1), and for the direct reactions ^{10}B(d,pγ)^{11}B($\frac{1}{2}^-,\frac{1}{2}$), ^{10}B(d,p$\gamma$)^{11}B($\frac{1}{2}^-,\frac{1}{2}$), ^{11}B(d,n$\gamma$)^{12}C(2$^+$,0) and ^{11}B(d,n$\gamma$)^{12}C(1$^+$,1). (L.B.S.)

29896 SPECTRA OF PROTONS EMITTED AT 137° BY NUCLEI UNDER BOMBARDMENT WITH PROTONS HAVING ENERGIES OF SEVERAL BeV. Bayukov, Yu. D.; Vorob'ev, L. S.; Kartashov, G. R.; Leksin, G. A.; Fedorov, V. B.; Khovanskii, V. D. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 521-6(Mar. 1966). (In Russian).

Measurements were made of the spectra of protons backscattered at 137° from polyethylene film and copper foil targets at 350 to 1000 MeV/c, using a spark chamber–scintillation spectrometer system. The shape of the proton spectra on carbon and copper was found to be similar, and to fall off rapidly with increase in momentum. Comparison is made with phase volume curves for the p + ^{12}C and p + α reactions. (L.B.S.)

29897 SHELL-MODEL CALCULATIONS FOR ^{18}O NUCLEI WITH VELOCITY-DEPENDENT TWO-PARTICLE POTENTIALS. Grote, Hans (Univ., Goettingen, Ger.). Z. Naturforsch., 22a: 415-21(Apr. 1967). (In German).

The energies of the low-lying levels and the absolute position of the ground state of the nucleus ^{18}O are calculated using five velocity-dependent potentials. The calculation is based on the shell model with two outer neutrons in the potential of the ^{16}O core. The interaction potential as well as the core potential are fitted to experimental data, leaving no free parameters in the final result. The wave functions of the harmonic oscillator are used in each case of the five velocity-dependent potentials. An additional computation is carried out using one of these potentials and taking into account the perturbation of the wave functions. It turns out that, for satisfactory application of the velocity-dependent potentials in shell-model calculations, this perturbation should be considered. (auth)

29898 ON THE POLARIZATION OF NEUTRONS FROM THE ^{11}B(p,n)^{11}C REACTION. Calboreanu, A.; Molea, M.; Dumitrescu, R.; Ciocanel, A.; Salageanu, O.; Minzatu, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 263-7(1967).

Experimental data on the polarization of neutrons from ^{11}B(p,n)^{11}C reaction are presented. Neutrons from the ground state of ^{11}C nucleus were analyzed at energies between 5.4 and 7.4 MeV, and appreciable degrees of polarization were found. At 7.4 MeV, the neutrons from the first excited state of ^{11}C are not polarized. (auth)

29899 STUDY OF THE (α,p) REACTIONS ON ^{10}B AND ^{12}C IN THE ENERGY RANGE FROM 12 TO 16 MeV. Ivascu, M.; Dumitrescu, R.; Semenescu, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 279-87(1967).

The excitation functions and angular distributions of protons resulting from $^{10}B(\alpha,p_0)^{13}C$ and $^{12}C(\alpha,p_0)^{15}N$ reactions were measured using alpha particles with energies between 12 and 16 MeV. The results show that the predominant mechanism is the direct interaction in the reaction $^{10}B(\alpha,p_0)^{13}C$. The angular distributions obtained were compared with the diffraction model where it is considered that the triton is captured with l = 3; good agreement was obtained for the interaction radius value of 6.2 10^{-13} cm for an energy of 13.4-MeV and 6.36 10^{-13} cm for 12.1 MeV. As for the $^{12}C(\alpha,p_0)^{15}N$ reaction, the presence of the 13.3- and 15.2-MeV resonances in the excitation function is assumed to be due to the mechanism of formation of the compound nucleus. The 13.3-MeV resonance manifests intensely in the 13.4-MeV angular distribution, which is almost symmetrical with respect to 90°. The 14.7- and 16.0-MeV distributions suggest that the mechanism of formation of the compound nucleus, as well as the direct interaction are present for these energies. (auth)

29900 PROJECTED HARTREE–FOCK SPECTRA OF 2s-1d-SHELL NUCLEI. Gunye, M. R. (Atomic Energy Establishment, Trombay, India); Warke, Chindhu S. Phys. Rev., 156: 1087-93 (Apr. 20, 1967).

The Hartree-Fock calculations with a phenomenological internucleon residual interaction are carried out for the 2s-1d-shell nuclei up to ^{25}Al. The low-lying excited states of these nuclei are obtained by projecting out good angular-momentum states from the deformed Hartree-Fock states. The energy spectra thus obtained are in good agreement with the experimental results. From the study of the odd–odd nuclei, it is found that the employed residual interaction correctly reproduces the ground-state spins of these nuclei. The binding energies calculated from the projected ground-state energies and a naive model are in very good agreement with the experimental binding energies. (auth)

29901 BETA-DELAYED PROTONS FROM ^{17}Ne. Esterlund, R. A.; McPherson, R.; Poskanzer, A. M.; Reeder, P. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 156: 1094-8 (Apr. 20, 1967). (BNL–10520).

^{17}Ne was produced by the $(^3He,2n)$ reaction on thin Al_2O_3 and gaseous O_2 targets, using the 32-MeV ^3He beam of the Brookhaven 60-in. cyclotron. In addition to previously reported delayed proton groups, new groups were observed at center-of-mass energies of 3.72, 6.12, and 10.48 MeV, and the half-life was determined to be 105 ± 5 msec. The highest-energy proton group, which constitutes 0.04% of the total protons observed, corresponds to decay of the analog state of ^{17}Ne at an excitation energy of 11.08 ± 0.08 MeV in ^{17}F. (auth)

29902 INELASTIC ELECTRON AND PROTON SCATTERING FROM NUCLEI. Haybron, R. M.; Johnson, M. B.; Metzger, R. J. (Oak Ridge National Lab., Tenn.). Phys. Rev., 156: 1136-45 (Apr. 20, 1967). (ORNL–P–2561).

The relation between the inelastic scattering of high-energy electrons and impulse-approximation scattering of protons from light nuclei was investigated for the excitation of collective levels described in a shell-model picture. A search code was developed to find best-fit form factors for the electron scattering to define the nuclear transition density for proton scattering. Calculations were performed for the first 2^+ and 3^- levels of ^{12}C. The data for the two types of probe were found to be consistent as regards enhancement and angular distribution for both transitions. The sensitivity of the comparison was tested by expressing the proton interaction in terms of three different sets of nucleon–nucleon phase shifts. The available data did not allow a choice of a preferred phase-shift set. (auth)

29903 LEVELS OF ^{18}F FROM THE $^{16}O(^3He,p\gamma)^{18}F$ REACTION. Olness, J. W.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 156: 1145-55(Apr. 20, 1967). (BNL-10823).

Angular correlations in the $^{16}O(^3He,p\gamma)^{18}F$ reaction were studied through two-parameter analyses of proton–gamma-ray coincidences at ^3He bombarding energies of 4.65, 5.40, and 6.40 MeV. Protons were detected by an annular solid-state detector centered at $\theta_p = 180°$; gamma rays were detected with a NaI(Tl) spectrometer for five angles in the range $0° \leq \theta_\gamma \leq 90°$. Branching ratios were determined for nine of the ten ^{18}F levels of $3.4 < E_{ex} < 4.9$ MeV; the exception is the 4.74-MeV level, which was not observed. From analysis of angular-correlation data the following spin–parity limitations are obtained for the triplet of levels at $E_{ex} \sim 3.8$ MeV: 3.72-MeV level (J = 1); 3.79-MeV level (J = 1, 2, or 3); and 3.84-MeV level ($J^\pi = 2^{(+)}$). The preference for an even-parity assignment for the 3.84-MeV level is quite strong. The decay modes of the 3.79-MeV level are consistent with the assumption that this is the 3^- member of the group of odd-parity levels which includes those at 1.08 MeV (0^-), 2.10 MeV (2^-), and 3.13 MeV (expected 1^-). For those levels with $E_{ex} > 4$ MeV, the correlation analysis provides restrictions on possible level spins and on multipole-mixing amplitudes for some of the principal deexcitation transitions. These results are consistent with other available information. The 4.65-MeV level of ^{18}F is found to have $J \geq 3$, and decays by transitions to the 0.94-MeV level ($J^\pi = 3^+$) and to the 1.13-MeV level [$J^\pi = (5)^+$] with branching ratios of 15 and 85%, respectively. This appears to be the most likely candidate for the $J^\pi = 4^+$, T = 1 analog of the 3.55-MeV 4^+ state of ^{18}O. The ^{18}F 4.40-MeV level is also observed to decay to the 1.13-MeV level, and is a possible but less likely candidate for the analog of this ^{18}O level. (auth)

29904 $^{13}C(\alpha,n)^{16}O$ REACTION CROSS SECTION BETWEEN 1.95 AND 5.57 MeV. Sekharan, K. K.; Divatia, A. S.; Mehta, M. K.; Kerekatte, S. S.; Nambiar, K. B. (Atomic Energy Establishment, Trombay, India). Phys. Rev., 156: 1187-90(Apr. 20, 1967).

The $^{13}C(\alpha,n)^{16}O$ total cross section was determined for the incident α-particle energy range 1.95 to 5.57 MeV using a 4π neutron detector. The total cross section of the inverse reaction $^{16}O(n,\alpha)^{13}C$ was calculated by applying the reciprocity theorem. The total level widths for 16 levels, and the partial widths Γ_α and Γ_n along with the reduced widths γ_α^2 and γ_n^2 for the levels corresponding to the 2.68, 2.81, 3.72, and 4.62-MeV resonances, were determined. (auth)

29905 STUDY OF THE TRANSITION OF THE 9.85-MeV LEVEL TO THE 6.06-MeV LEVEL IN ^{16}O. Gorodetzky, S.; Adloff, J. C.; Chevallier, P.; Disdier, D.; Gorodetzky, Ph.; Rauch, V.; Scheibling, F. (Institut de Recherches Nucleaires, Strasbourg). Phys. Lett., 24B: 578-9(May 29, 1967). (In French).

The transition probability of the transition 9.85 MeV ($J^\pi = 2^+$) → 6.06 MeV ($J^\pi = 0^+$) was determined with the aid of the ^{12}C (α,γ_{π}) ^{16}O reaction. The width $\Gamma_{9.85\ MeV \rightarrow 6.06\ MeV} = 1.89 \pm 0.42$ MeV corresponds to a reduced probability $B(E2) = 2.95 \pm 0.66\ e^2fm^4$. (auth)

29906 STUDY OF THE REACTION $^{12}C(\alpha,\gamma_0)^{16}O$ IN THE EXCITATION ENERGY RANGE 14 TO 24.7 MeV. Suffert, M.; Feldman, W. (Stanford Univ., Calif.). Phys. Lett., 24B: 579-82 (May 29, 1967).

The differential cross-section at 45° for the reaction $^{12}C(\alpha,\gamma_0)^{16}O$ was measured for incident energies from 8.75 to 23.50 MeV. Over the entire range the cross section is smaller than 0.5 $\mu b/sr$. Three major resonances were investigated, and their parameters are presented. (auth)

29907 T = ½ STATES IN ^{13}N OBSERVED IN THE REACTION $^{12}C(p,p)^{12}C$. Kuan, H. M.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Lett., 24B: 566-7(May 29, 1967).

In addition to the previously reported first T = ½ state at E_x = 15.068 MeV in ^{13}N, two higher T = ½ states at 18.43 and 18.98 MeV are observed in the reaction $^{12}C(p,p)^{12}C$ which is "twice-forbidden" by isospin conservation. (auth)

29908 POLARIZATION AND DIFFERENTIAL CROSS SECTION FOR ELASTIC SCATTERING OF 40-MeV PROTONS. II. Fricke, M. P.; Gross, E. E.; Morton, B. J.; Zucker, A. (Oak Ridge National Lab., Tenn.). Phys. Rev., 156: 1207-18(Apr. 20, 1967). (ORNL–P–2729).

Polarization and differential-cross-section data are presented for the elastic scattering of 40-MeV protons from eleven targets: ^{12}C, ^{28}Si, ^{40}Ca, ^{54}Fe, ^{58}Ni, ^{59}Co, ^{60}Ni, ^{65}Zn, ^{90}Zr, ^{120}Sn, and ^{208}Pb. These data were analyzed with a 10-parameter optical model from which "average parameters" were obtained. The average parameters provide a good fit to our data and lead to a value of about 26 MeV for the depth of the symmetry part of the real central potential. Satisfactory fits to existing 30-MeV data are also realized with these average parameters which, together with the fits to the 40-MeV data, result in an energy dependence of the real central potential of about −0.22 MeV per MeV increase in proton beam energy. Behavior of the l = 0 optical-model reflection coefficients is studied as a function of A and appears to be consistent with a mean free path for a reaction in nuclear matter of about 7 F. (auth)

29909 ELASTIC SCATTERING OF NEUTRONS FROM O AND Ar AT 14.0 MeV. Beach, P. L; Finlay, Roger W.; Cassola, R. L.; Koshel, R. D. (Ohio Univ., Athens). Phys. Rev., 156: 1201-6 (Apr. 20, 1967).

Differential cross sections of 14-MeV neutrons elastically scattered from liquid samples of O and Ar were measured using associated-particle time-of-flight techniques. Careful attention was given to the subtraction of background neutrons scattered from the Dewar walls. The corrected data were analyzed in terms

of four- and six-parameter optical-model calculations. A possible ambiguity in the imaginary potential for oxygen is discussed. The sensitivity of the results to the parameters in the spin-orbit potential is also examined. (auth)

29910 ISOSPIN QUADRUPLETS IN A = 15 NUCLEI. Loncke, P.; Pradal, J. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim. (10), 48B: 457-9(Apr. 11, 1967).

The shell model is not successful for interpreting the $T = 3/2$ levels of ^{15}N. It predicts a $5/2^+$ level at 11.7 MeV and a $1/2^+$ level at 12.6 MeV, which is exactly the opposite of the experimental ordering. A similar situation occurs for the analogous states of ^{15}C. The influence of configuration mixing on the excitation energies of these levels was investigated in order to determine whether or not the residual interaction is able to reverse the order of these levels. (S.F.L.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 28193, 29879, 29880, 29887, 29893, 29896, 29908, 29909, 29966–29969, 30020, 30021, 30023, 30042, 30049, 30050, 30073, and 30078.

29911 (AE-270) AN OPTICAL MODEL STUDY OF NEUTRONS ELASTICALLY SCATTERED BY IRON, NICKEL, COBALT, COPPER, AND INDIUM IN THE ENERGY REGION 1.5 TO 7.0 MeV. Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1967. 22p. Dep.

Angular distributions of elastically scattered neutrons were measured for cobalt and copper at nine energies between 1.5 and 7.0 MeV, for natural iron at 4.6 MeV, for natural nickel and indium at four energies between 3.0 and 4.6 MeV, by using time-of-flight technique. The observed angular distributions were corrected for neutron flux attenuation, multiple elastic scattering, and the finite geometry of the source-sample-detector system by using a Monte Carlo program. Theoretical angular distributions were fitted to the experimental angular distributions by using an optical model potential of the form $-V(r) = Uf(r) + iWg(r) + U_{so}\,(\hbar/\mu_\pi c)^2\, 1/r\, d/dr\, |f(r)|\vec{\sigma}\cdot\vec{l}$ with Saxon–Woods form factors. A computer program was used to find parameter values of the potential giving the best fittings to the experimental angular distributions. (auth)

29912 (BARC-276) SPINS OF THE FIRST TWO EXCITED STATES IN ^{27}Mg BY AN ANGULAR CORRELATION TECHNIQUE IN THE REACTION $^{26}Mg(d,p\gamma)^{27}Mg$. Eswaran, M. A.; Ragoowansi, N. L.; Mitra, P. C. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 19p. Dep.

Proton–gamma angular correlation measurements, employing the method II of Litherland and Ferguson, were made in the reaction $^{26}Mg(d,p\gamma)^{27}Mg$, using a 1.80-MeV deuteron beam and detecting the outgoing protons at 0° with respect to the beam. The analysis of these measurements leads to spin assignments of $3/2$ and $5/2$ for the 0.98- and 1.69-MeV excited states of ^{27}Mg, respectively. The 1.69-MeV second excited state is found to decay almost completely to the ground state. (auth)

29913 (KFK-504) UNTERSUCHUNG VON DEUTERON-BREAK-UP NEUTRONEN MIT EINER FLUGZEITMETHODE BEI 50 MeV. (Investigation of Deuteron-Break-Up Neutrons by a Time-of-Flight Method at 50 MeV). Schweimer, G. W. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Oct. 1966. 54p. (In German). Dep.

In the irradiation of targets (Be, C, Al, Fe, Co, No, Cu, Nb, Mo, Pb, Ag, Ta, Pt, and Au) with 50-MeV deuterons, a broad neutron spectrum with a maximum intensity at about 25 MeV arises. This neutron spectrum is principally formed of deuteron breakup neutrons. For the theoretical description of the neutron spectrum, a potential (optical nuclear potential and Coulomb potential) dependent only on A and Z was introduced. The shell structure of the target nucleus obtained in the neutron spectra in the area at the half deuteron energy is not remarkable. In the light nuclei ($Z < 24$) the nuclear potential contributes principally to the breakup and for heavy nuclei ($Z > 24$) the contribution of the Coulomb potential is preponderant. (tr-auth)

29914 (NP-16764) SPECTRUM SHAPES OF FIRST FORBIDDEN BETA TRANSITIONS. Beekhuis, Henricus (Groningen Rijksuniversiteit (Netherlands)). 1967. 117p. Dep. Thesis.

Shape measurements were made of first-forbidden beta transitions in the nuclei ^{24}Na, ^{141}Ce, ^{142}Pr, ^{147}Nd, ^{166}Ho, ^{198}Au, and ^{199}Au using a magnetic lens spectrometer, consisting of a cylindrical vacuum chamber with diaphragms, around which current carrying coils and an iron yoke are placed. Beta particles emitted from the source are transmitted through the diaphragms and are focused on the detector. At each spectrometer current, only beta particles in a narrow energy range reach the detector. The counting rate of the detector, measured as a function of spectrometer current, yields the required energy distribution of the beta particles. Methods for optimizing and testing the instrument for precise shape measurements are treated. The theory of first forbidden beta decay is also discussed. (S.F.L.)

29915 (ZfK-PhA-25) RECHNUNGEN ZUM NIVEAUSCHEMA VON V^{52} IM SCHALENMODELL. (Calculation of the Level Scheme of ^{52}V by the Shell Model). Gersch, Hans Ulrich; Riedel, Claus; Rudolph, Werner (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Jan. 1967. 36p. (In German). Dep.

Based on the assumption that the low-lying states of ^{52}V can be described by three protons in the $f_{\frac{7}{2}}$ shell and one neutron in the $p_{\frac{3}{2}}$, $p_{\frac{1}{2}}$, and $f_{\frac{5}{2}}$ shells, the excitation energies and the corresponding eigenfunctions were calculated. For the matrix elements of the proton-neutron interaction, the potential of an exchange force with a Gaussian radial shape was used. The range and the strength of this potential as well as the exchange character of the proton-neutron force were treated as free parameters. On the other hand, the matrix elements of the proton-proton interaction were determined using the level scheme of the neighboring nucleus ^{51}V. The single-particle energies are also taken from experimental data. The results of the shell-model calculation are sufficiently good for a not very sharp region in the parameter space. They give a fairly good agreement not only with the experimental level scheme, but also with the spectroscopic factors for the $^{51}V(d,p)^{52}V$ reaction, the branching ratios for M1 transitions, and the lifetime of a recently found 5^+ isomeric state. (auth)

29916 RADIATION CAPTURE OF THERMAL NEUTRONS BY ^{52}Cr NUCLEUS. Belousova, V. I.; Rudak, E. A.; Firsov, E. I. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 2, 128-9 (1966). (In Russian).

The Saxon–Woods potential in the Schroedinger equation is replaced with a simpler expression for the potential, and wave functions of this type are used to evaluate the cross section for E1-type transitions for an energy of 7.93 MeV from the capture state of the ^{53}Cr nucleus in (n,γ) reactions for thermal n in the ground $p_{\frac{3}{2}}$ state. The cross section depends strongly on the parameter for the diffuseness of the edge of the potential well. A value of 0.23 b is the max for the given transition. (auth)

29917 NUCLEAR PARAMETERS FROM THE MEASUREMENTS OF THE β-DECAY SPECTRUM. Balazs, E. (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung., 22: 29-45(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

A general formula is given for the shape factor of the energy spectrum of the β-decays forbidden in arbitrary high order. The method used allows one to take into account configuration mixing, too. New equations obtained from the measurements of the shape factor provide a possibility to learn experimentally about new matrix elements characteristic for the nuclei participating in the transition. The numerical discussion of the decay $^{36}Cl \rightarrow {}^{36}S$ is investigated as an example. (auth)

29918 A SHELL-MODEL STUDY OF ^{43}Sc. Flowers, B. H.; Johnstone, I. P. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 91: 310-18(June 1967).

The odd-parity levels of ^{43}Sc are calculated allowing the three extra-core particles to occupy the complete 1f2p shell. It is found that the energy levels are fairly insensitive to changes in the two-body interaction, and that, although agreement is obtained with some of the experimental data, several features of the empirical spectrum are not accounted for this way. These results, and stripping data from the $^{42}Ca(^3He,d)^{43}Sc$ reaction, suggest that there are low-lying states arising mainly from two-particle excitations of the ^{40}Ca core. (auth)

29919 STUDY OF THE ANGULAR CORRELATION OF THE $^{24}Mg(d,p\gamma)^{25}Mg$ STRIPPING REACTION. Farouk, M. A.; Comsan, M. N. H.; El-Behay, A. Z.; Zaloubovskii, I. I. (Atomic Energy Establishment, Cairo). Atomkernenergie, 12: 133-6(Mar.-Apr. 1967).

Angular correlations between protons from the $^{24}Mg(d,p)^{25}Mg$ reaction leading to the 3.408-MeV excited state of ^{25}Mg and the resulting de-excitation gamma rays were investigated at deuteron energies of 2.00 and 2.400 MeV. The correlations were studied at laboratory proton scattering angles of 30, 60, and 120° in the reaction plane. The correlation function found by least-squares fits to the experimental data obtained at $E_d = 2.00$ MeV and at the proton scattering angle $\Theta_p = 30°$ is in good agreement with the simple Butler theory. Angular correlations measured at the same proton scattering angle and at $E_d = 2.40$ MeV are in good

agreement with the prediction of the distorted wave theory and not with the plane wave theory. Correlation measurements at the proton scattering angle $\Theta_p = 60°$ show considerable shift between the true symmetry axis and the nuclear recoil axis at both deuteron energies. The correlation functions are in good agreement with the prediction of the distorted wave theory. (auth)

29920 ANGULAR DISTRIBUTION OF PROTONS FROM THE (d,p) REACTION IN ^{56}Fe. Sen Gupta, H. M. (Univ. of Dacca, Pakistan); Hannan, A. H. M. A.; Khan, A. H.; Hossain, A. Nuovo Cim. (10), 49B: 207-10(June 11, 1967).

The determination of the properties of the excited states of ^{57}Fe as obtained from the (d,p) reaction in ^{56}Fe is considered. Protons emitted from the bombardment of an enriched ^{56}Fe target with a beam of 12-MeV deuterons were analyzed in a multichannel magnetic spectrograph and recorded in Ilford K2 emulsions. Energy levels in ^{57}Fe were obtained from the measurements of the energy spectrum of protons, whose angular distributions are shown. (J.F.P.)

29921 COLLECTIVE LEVELS IN ^{32}S. Gregoire, G.; Macq, P. C. (Univ., Louvain, Belg.). Nucl. Phys., A99: 481-6(1967). (In French).

Angular distributions of elastically and inelastically scattered alpha particles on ^{32}S are presented for an incident energy of 23.8 ± 0.2 MeV. The distributions corresponding to the ground state and first excited state are in agreement with the simple picture of diffraction scattering. It is shown that the scattering behavior and electromagnetic properties of the 3.78-MeV level and the 4.29–4.47 levels (not resolved) are in disagreement with a vibrational description. (auth)

29922 STUDY OF ^{63}Cu AND ^{65}Cu LEVELS BY THE (t,α) REACTION. Bachner, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Bock, R.; Duhm, H. H.; Santo, R.; Stock, R.; Hinds, S. Nucl. Phys., A99: 487-96(1967).

The reactions ^{64}Zn(t,α)^{63}Cu and ^{66}Zn(t,α)^{65}Cu were studied at an incident triton energy of 13 MeV using a broad-range multiangle spectrograph. Angular distributions up to an excitation energy of about 4.5 MeV were obtained and are analyzed by the DWBA theory. The results provide information about the ^{64}Zn and ^{66}Zn ground-state configurations as well as the proton hole states in ^{63}Cu and ^{65}Cu. Some evidence is found for inelastic mechanisms affecting the magnitude of pickup cross sections for levels with large collective components. (auth)

29923 PROPERTIES OF LOW-LYING LEVELS IN ^{59}Co. Agarwal, Y. K.; Baba, C. V. K.; Bhattacherjee, S. K. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A99: 457-64 (1967).

The half life and the magnetic dipole moment of the 1290 keV ($\frac{3}{2}^-$) state in ^{59}Co were measured to be 0.59 ± 0.02 ns and 1.90 ± 0.35 nm, respectively. These and other properties of the 1100- and 1290-keV levels in ^{59}Co were explained by assigning a mixture of $p_{\frac{3}{2}}$ and $\{f_{\frac{5}{2}}, 2^+; \frac{3}{2}^-\}$ configurations to these levels. (auth)

29924 ENERGY LEVELS IN ^{23}Na. Dubois, J. (California Inst. of Tech., Pasadena). Nucl. Phys., A99: 465-72(1967).

The energy levels in ^{23}Na were investigated by means of the reaction ^{25}Mg(d,α)^{23}Na. Deuterons with energy of 10.0 MeV were accelerated with the ONR-CIT tandem accelerator and the reaction products were analyzed with a double-focusing magnetic spectrometer at 20, 30, and 60°. The level density agrees with that for ^{23}Mg. No evidence for levels at 2.405 and 2.870 MeV in ^{23}Na was found. (auth)

29925 STRUCTURE IN THE TOTAL ^{24}Mg(n,p), ^{27}Al(n,p), AND ^{27}Al(n,α) CROSS SECTIONS FROM 12 TO 15 MeV. Ferguson, J. M.; Albergotti, J. C. (Naval Radiological Defense Lab., San Francisco). Nucl. Phys., A98: 65-74(1967).

The relative cross sections of the ^{24}Mg(n,p), ^{27}Al(n,p), and ^{27}Al (n,α) reactions were measured with accuracies of a few per cent or better. All three excitation functions fluctuate with periods of the order of a few hundred keV and magnitudes of a few per cent. The observed structure is consistent with the Ericson theory. (auth)

29926 LIFETIME AND g FACTOR OF FIRST EXCITED STATE OF ^{57}Co. Beraud, R.; Berkes, I.; Marest, G.; Rougny, R. (Institut de Physique Nucleaire, Lyon). Nucl. Phys., A98: 154-60(1967). (In French).

A direct lifetime measurement of the first excited level of ^{57}Co and the rotation of the angular correlation pattern of the 127-1378 keV cascade in an internal magnetic field were investigated. The measured values are $\tau = 28 \pm 5$ ps and $g = +1.9 \pm 0.6$. The lifetime is compared with that of the lowest excited states of ^{59}Co. (auth)

29927 THE REACTIONS ^{22}Ne(d,n)^{23}Na AND ^{28}Si(d,n)^{29}P. Mubarakmand, S.; Macefield, B. E. F. (Nuclear Physics Lab., Oxford). Nucl. Phys., A98: 97-112(1967).

The reactions ^{22}Ne(d,n)^{23}Na and ^{28}Si(d,n)^{29}P were studied. Spin, parities, and relative spectroscopic factors were determined. The reactions were studied by neutron time-of-flight techniques and the data were analyzed using DWBA without spin-orbit potentials. Angular distributions of the neutron groups from the reaction ^{22}Ne(d,n)^{23}Na leading to the known states at 5.5, 6.27, 7.21 and, 7.79 MeV in ^{23}Na yield $l_p = 2, 0, 1$, and 2 respectively, and also two new states at 7.42 and 8.62 MeV in ^{23}Na were excited with $l_p = 1$ and 0 respectively. There is strong evidence to suggest that the 8.62 MeV state is the analog of the first excited state in ^{23}Ne. Angular distributions in the reaction ^{28}Si(d,n)^{29}P going to the ground state and excited states in ^{29}P at 1.38 and 2.4 MeV yield $l_p = 0$, 2 and 2 respectively. (auth)

29928 REACTIONS OF ^{88}Sr WITH PROTONS OF ENERGIES 7 TO 85 MeV. Sachdev, D. R.; Porile, N. T.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 45: 1149-60(May 15, 1967).

Excitation functions for the (p,xn) (x = 1 to 5), (p,p3n), and (p,2pxn) (x = 1, 3, 4) reactions induced in ^{88}Sr by protons of energy from 7 to 85 MeV were measured by radiochemical methods. Cross sections for the individual isomeric species for the products of (p,2n), (p,3n), (p,4n), and (p,p3n) reactions are presented. Excitation functions for each of the (p,2p3n) and (p,2p4n) reactions exhibit two peaks, the first of which is assigned to (p,α2n) reactions from threshold considerations. The experimental results are compared with Monte Carlo calculations using the codes of Chen et al. for the cascade stage and Dostrovsky et al. for the evaporation stage. The comparison suggests that the calculations of Chen et al. overestimate the extent of compound nucleus contribution at high energies. (auth)

29929 THE ^{37}Cl(p,γ)^{38}Ar REACTION. Awaya, Takashi; Ohmura, Haruko; Sakurai, Kiyoko; Takahashi, Noriyuki (Tokyo Univ.). J. Phys. Soc. Jap., 22: 935-6(Mar. 1967).

Excitation functions for gamma rays with energies greater than 1.5 MeV were measured using natural and enriched targets in the proton energy ranges of 0.66 to 1.43 MeV and 0.84 to 1.13 MeV, respectively. Level schemes for ^{38}Ar were proposed. (D.C.W.)

29930 EXCITATION OF SPIN-FLIP STATES OF LIGHT NUCLEI IN INELASTIC SCATTERING OF ALPHA PARTICLES. Nakamura, Hitoshi (Kyoto Univ.). J. Phys. Soc. Jap., 22: 685-97(Mar. 1967).

Angular distributions of inelastically scattered alpha-particles, leading to the $\Delta T = 0$ spin-flip states of ^{12}C at 12.7 MeV and ^{11}B at 8.6 MeV, were observed. These angular distributions were found to show a unique pattern. Such characteristics of the angular distributions were also observed for the 10.4-MeV state of ^{24}Mg and the 8.9 MeV state of ^{28}Si. These four states were systematically interpreted as the $\Delta T = 0$ spin-flip states by the j-j coupling shell model. The excitation mechanism for these states is discussed, and it is concluded that a spin-orbit interaction between the incident alpha-particle and a nucleon in the target nucleus plays an important role. The angular distribution for another unnatural-parity state of ^{12}C at 11.8 MeV (2^-), ^{24}Mg at 5.22 MeV(3^+), and ^{28}Si at 6.27 (3^+) were also observed. The 14.08-MeV collective state of ^{12}C was found to be excited strongly. (auth)

29931 CROSS SECTIONS OF DEUTERON INTERACTION WITH ALUMINUM AT 710 MeV. Bisheva, G. K.; Borisov, V. S.; Goldin, L. L.; Kondrat'ev, L. N.; Sidorenko, Z. S.; Sukhorukov, S. T.; Tumanov, G. K. (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Lett., 24B: 533-6(May 15, 1967).

Cross sections of interactions of deuterons with aluminum at 710 MeV are reported. The data are discussed in terms of the optical model for a complex particle assuming the nucleus to be absolutely black. (auth)

29932 PAIRING INTERACTION BETWEEN NUCLEONS AND THE ENERGY POSITIONS OF SINGLE-PARTICLE LEVELS. Kurdyumov, I. V.; Yadrovskii, E. L. (Moscow State Univ. Ural Polytechnical Inst., Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 494-500(Mar. 1966). (In Russian).

Calculations were carried out of the positions of the single-particle levels in $f_{\frac{7}{2}}$-shell nuclei, using a method which reduces to calculation of the diagonal matrix elements. A narrow nuclear region was chosen in order to investigate the effects of interest in greater detail. The results show that the shell model taking into account pairing interactions satisfactorily describes the pecularities shown in the behavior of single-particle levels. In particular, the symmetry energy effect may be interpreted as due primarily to Heisenberg forces in the exchange interaction potential. The relation between the term dependent on the isotopic spin in the optical potential and the pairing charge-exchange in-

teraction between the nucleons in the oscillator well is also briefly discussed. (L.B.S.)

29933 VALUES OF THE K/β^+ RATIO FOR THE ALLOWED $4^+ \rightarrow 4^+$ TRANSITION IN ^{48}V AND THE $2^+ \rightarrow 2^+$ TRANSITION IN ^{58}Co. Biryukov, E. I.; Zaletskii, E. G.; Shimanskaya, N. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 504-10(Mar. 1966). (In Russian).

Several series of measurements were carried out of the K/β^+ branching ratio for ^{48}V and ^{58}Co. The results are tabulated along with other experimental and theoretical values. (L.B.S.)

29934 RADIATIVE PROTON CAPTURE BY ^{36}S AND EXCITED STATES OF ^{37}Cl. Koval', A. A. (Inst. of Physics and Tech., Kiev); Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 416-25 (Mar. 1966). (In Russian).

The excitation function of the ^{36}S(p,γ)^{37}Cl reaction was measured at 1400 to 2100 keV. The positions of 65 resonances and the energies of the corresponding levels in ^{37}Cl were determined. Gamma angular distributions were measured for 11 resonances, and the results, processed by the method of least squares, were compared with various theoretical hypotheses by the chi-square test technique. The probable spin assignments for the resonance levels and the probable values of the multipole mixing coefficient for the transitions to the ground state were determined. (L.B.S.)

29935 LEVELS OF ^{30}P. L'vov, A. N.; Popov, A. I.; Sorokin, P. V.; Storizhko, V. E. (Inst. of Physics and Tech., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 439-43(Mar. 1966). (In Russian).

Comprehensive measurements were made of the excitation functions of the (p,p), (p,γ), and (p,p'γ) reactions on ^{29}Si from 1200 to 3100 keV. Fifty resonances were detected in this energy range. The resonance proton energies, excitation energies of the levels of the compound nucleus ^{30}P, the total width of these levels, and their modes of decay are tabulated. Measurements were also made of angular distributions of the γ rays emitted incident to inelastic scattering. (L.B.S.)

29936 ANGULAR DISTRIBUTION OF GAMMA RADIATION FROM COULOMB EXCITATION OF ^{65}Cu, ^{93}Nb, ^{105}Pd, AND ^{117}Sn NUCLEI. Gusinskii, G. M.; Lemberg, I. Kh. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 449-54(Mar. 1966). (In Russian).

The angular distributions of gamma rays emitted from Coulomb excited nuclei were studied to determine the spins of excited levels and relative intensities of the E2 and M1 transitions. Bombardment was accomplished with alpha-particle having energies of 7.24, 7.85, and 9.6 MeV, and 48.3-MeV nitrogen ions accelerated in the Physical-Technical Institute cyclotron. Measurements were made at backscatter angles of 0 to 90 deg with two NaI(Tl) scintillation crystals 7 cm from the target. A 128-channel pulse amplitude analyzer was used to record the scintillator outputs. Results of angular measurements, given in a table, indicate the characteristics of the levels and transitions. Specific experiments performed on each of the nuclei are detailed, and the reduced transition probabilities and partial lifetimes of the levels are tabulated. (JPRS)

29937 DETERMINATION OF THE RESONANCE ACTIVATION INTEGRALS OF ^{41}K, ^{51}V, AND ^{55}Mn. Koehler, W.; Schmelz, H. (Technische Hochschule, Munich). Nukleonik, 9: 270-3(Apr. 1967). (In German).

By simultaneous irradiation of samples of ^{41}K, ^{51}V, and ^{55}Mn and of thin gold foils with Cd covers of 1 mm thickness in the pneumatic irradiation facility and by determining the activity after a short waiting time the resonance activation integral cross sections I_{res} were determined. The lower limit of I_{res} is the cadmium cut-off for the given geometry, in this case 0.68 eV. The 1/v contribution to the resonance activation integral was calculated and subtracted from I_{res} to obtain I'_{res}. A determination by cadmium ratio measurements was also made. Using this method the standard deviations are greater (two irradiations instead of one for each value), but the mean values agree with the other ones within the limits of error. The value for ^{55}Mn agrees with the measurements of Dahlberg, $I'_{res} = 8.16 \pm 0.6$ barn, but it does not agree with that of Vidal, $I'_{res} = 10.5 \pm 1.1$. (auth)

29938 ISOMERIC CROSS SECTIONS RATIOS FOR SOME (n,γ) REACTIONS. Foglio Para, A.; Mandelli Bettoni, M. (Politecnico, Milan). Energ. Nucl. (Milan), 14: 228-37(Apr. 1967).

The isomeric cross sections ratios for the (n,γ) reactions on ^{85}Rb, ^{84}Sr, ^{86}Sr, ^{130}Ba, ^{177}Hf, and ^{178}Hf were measured utilizing the facilities of L54 reactor of CESNEF, Politecnico di Milano. The experimental values of the cross sections for the activation of the metastable and ground states (σ_m and σ_g) are reported together with the inferred isomeric ratios $\sigma_m/(\sigma_m + \sigma_g)$. These latter are then compared with the theoretical results of the statistical approach of Huizenga and Vandenbosch, based on the so-called shifted Fermi gas model. In the case of ^{85}Rb and ^{177}Hf it is also possible to determine the spin value of the compound nucleus. (auth)

29939 DYNAMIC ORIENTATION OF ^{60}Co NUCLEI. Hirakawa, Hiromasa; Morimoto, Kimio (Tokyo Univ.). J. Phys. Soc. Jap., 21: 1902-4(Oct, 1966).

Dynamic orientation of ^{60}Co nuclei by forbidden transitions in the paramagnetic resonance was studied at T ~ 2.1°K, with $\nu \sim$ 35 kMc/sec, $\Delta = h\nu/kT \sim 0.8$. Single crystals of $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$ containing Co nuclei were used. Paramagnetic resonance lines were saturated with an r-f power of ~10mw. Orientation of ^{60}Co was detected by counting γ rays emitted in a direction perpendicular to the magnetic field. The nuclear alignment P_2 was ±1.3% and ±2.3% for crystal orientations $Z'_1H \| H_1$ and $Z' \| Z' \| H_1H_1$ respectively. The spin Hamiltonian constants of ^{60}Co, A = 0.0050 and B = 0.0059, agree with those given previously. (NSA of Japan)

29940 THE POLARIZATION OF ELASTICALLY SCATTERED PROTONS ON Al, Mg, Cu, Zn AT 6.6 AND 7.4 MeV. Boca, I.; Borsaru, M.; Cenja, Marcela; Hategan, C.; Iliescu, E. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 323-4(1967).

The results of some measurements of the angular distributions of the polarization of protons elastically scattered by Al, Cu, ^{24}Mg, and Zn at 6.6 and 7.4 MeV are presented. (D.C.W.)

29941 FAST-SLOW SPEED COINCIDENCE SCHEME IN TRANSISTORS FOR SIMULTANEOUS RECORDING OF FOUR-ANGLE CORRELATIONS (pp'γ). Skyntei, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 297-304(1967). (In Russian).

An electronic system that permits the simultaneous measurement of four (p,p'γ) angular correlations using a single 400-channel analyzer is described. The advantage of the system consists of the fact that simultaneous measurement of the correlation curves permits a very precise comparison of the curves. The best operating of the systems that compose the installation are given for a specific experiment. The entire system is transistorized. (tr-auth)

29942 EXPERIMENTAL CHAMBER CAPABLE OF SIMULTANEOUS RECORDING OF FOUR-ANGLE CORRELATIONS (pp'γ). Skyntei, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 289-95(1967). (In Russian).

An experimental chamber that permits the simultaneous measurement of four (p,p'γ) angular correlation curves is described. Details of construction and of operation with gaseous or solid targets are given. The optimum operating conditions of the chamber in a cyclotron beam are outlined, and the spectrum from the ^{26}Mg(p,p'γ) reaction at 6.46 MeV is presented as an example. (tr-auth)

29943 NEUTRON EVAPORATION SPECTRA FROM (α,n) REACTIONS ON MEDIUM AND HEAVY NUCLEI. Magda, M. T.; Lukas, Ingrid R.; Plostinaru, D.; Trutia, Elena; Alevra, A.; Dumitrescu, R. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 235-41(1967).

The energy distribution of neutrons emitted from the (α,n) reactions on ^{28}Si, ^{51}V, ^{52}Cr, ^{59}Co, ^{75}As, ^{103}Rh, ^{115}In, and ^{139}La was studied. The values of the level density parameters were determined by an analysis based on the statistical model of nuclear reactions and were compared with the predictions of the Fermi gas model. (auth)

29944 MEASUREMENT AND DISTORTED-WAVE BORN-APPROXIMATION ANALYSES OF THE 18.7-MeV CROSS SECTIONS FOR THE ^{23}Na(α,$d_{0,1}$)^{25}Mg REACTIONS. Srivastava, B. B.; Johnson, O. E. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 156: 1219-24(Apr. 20, 1967). (COO-1420-128).

The 18.7-MeV differential cross sections for the ^{23}Na(α,$d_{0,1}$)^{25}Mg reactions were determined at 5° intervals over the angular range from about 25° to 170°. The spectrometer system included an (E × ΔE) particle identifier, an (E,ΔE) counter telescope consisting of two silicon surface-barrier detectors, and a multichannel pulse-height analyzer. One target each of sodium hydride (266 ± 10 μg/cm^2) and metallic sodium (267 ± 10 μg/cm^2) was used. The target material was vaporized in a vacuum and condensed onto a thin (~20 μg/cm^2) Formvar substrate. The integrated cross sections for the transitions to the ground and 0.584-MeV states of ^{25}Mg are 1377 ± 30 μb (23.1° to 171.6°) and 349 ± 9 μb (34.7° to 171.6°), respectively. The angular distributions are similar in over-all shape and exhibit a somewhat washed-out structure with strong backward-angle peaking. This similarity could not be correlated in a simple way with any of the known properties of the nuclear states. Distorted-wave Born-approximation analyses of the data have been made in terms of both zero-range knockout and zero-range stripping models. In the knockout

model, the initial (final) nuclear state is described as a two-body system consisting of a deuteron (an α particle) bound to a ^{21}Ne core, and in the stripping model the final nuclear state is described as a deuteron bound to a ^{23}Na core. Using reasonable parameter values, the gross features of both angular distributions could be marginally reproduced by the knockout model but not by the stripping model. The knockout analyses require a $1g_{9/2}$ state for the (d,^{21}Ne) system representing the ground state of ^{23}Na, and require $2d_{5/2}$ and $2d_{3/2}$ states for the (α,^{21}Ne) system representing the ground and 0.584-MeV states of ^{25}Mg, respectively. (auth)

29945 THERMAL-NEUTRON COHERENT SCATTERING AMPLITUDES AND CROSS SECTIONS OF ^{61}Ni AND ^{64}Ni. Sidhu, S. S.; Anderson, K. D. (Argonne National Lab., Ill.). Phys. Rev., 156: 1225-8(Apr. 20, 1967).

The values of coherent nuclear scattering amplitudes obtained by neutron diffraction studies of isotopically enriched samples of ^{61}Ni and ^{64}Ni are: $b_{Ni^{61}} = +0.760 \times 10^{-12}$ cm and $b_{Ni^{64}} = -0.037 \times 10^{-12}$ cm. Since ^{62}Ni is already known to possess an anomalous negative scattering amplitude, the value obtained for $b_{Ni^{64}}$ shows that the nickel element has two isotopes, ^{62}Ni and ^{64}Ni, which possess anomalous scattering amplitudes for slow neutrons. These results suggest a further search for nuclear scattering resonance effects on the observed neutron scattering for the nickel isotopes. (auth)

29946 NUCLEAR SPECTROSCOPY IN ^{52}Cr, ^{53}Cr, AND ^{54}Cr BY THE (p,d), (p,t), AND (p,p') REACTIONS. Whitten, C. A. Jr. (Princeton Univ., N. J.). Phys. Rev., 156: 1228-48(Apr. 20, 1967). (PUC-937-230).

The ^{54}Cr(p,d) and ^{54}Cr(p,t), ^{53}Cr(p,d) and (p,t), ^{53}Cr(p,p'), and ^{52}Cr(p,t) reactions were studied with 17.5-MeV protons from the Princeton FM cyclotron. Thin, essentially self supported, isotopic chromium foils were used in these experiments, the deuterons and tritons being identified by a dE/dx-E solid-state-detector telescope. The total experimental resolution of this system for the various deuteron and triton groups was between 55 and 70 keV. Angular distributions for many (p,d), (p,t), and (p,p') transitions were obtained from 15° to 150°. Spectroscopic factors were determined for $l_n = 0$, 1, 2, and 3 (p,d) transitions, using distorted-wave Born-approximation calculations which included both finite-range and nonlocal effects. In the ^{53}Cr(p,d) reaction, both the 0^+ ground state and the 1.434-MeV 2^+ level in ^{52}Cr were excited by $l_n = 1$ transitions, showing admixture in the ^{53}Cr ground state of the configuration $\{(^{52}\text{Cr } 1.434 \text{ MeV})^{2+}2p_{3/2}\}^{1/2}$. Levels in ^{52}Cr and ^{53}Cr were strongly excited in the (p,d) reaction with $l_n = 3$ angular distributions, and these transitions are ascribed to $1f_{7/2}$ pickup. In the ^{54}Cr(p,d)^{53}Cr reaction, definite J dependence was observed in both $l_n = 1$ ($J = 1/2$ or $3/2$) and $l_n = 3$ ($J = 5/2$ or $7/2$) transitions. A single $l_n = 0$ transition was found in the ^{54}Cr(p,d) reaction which seems to exhaust most of the $T_<$ spectroscopic strength. The ^{54,53,52}Cr(p,t) experiments along with the ^{53}Cr(p,d) work indicate that a large component of the 2.648-MeV 0^+ level in ^{52}Cr is a two-particle–two-hole neutron configuration. In the ^{53}Cr(p,p') reaction the 0.563-MeV $1/2^-$, 1.001-MeV $5/2^-$, 1.284-MeV $7/2^-$, and 1.967-MeV levels were strongly excited, and their angular distributions are similar to that of the ^{52}Cr(p,p')^{52}Cr 1.434-MeV 2^+ transition. The results of the ^{54}Cr(p,d), ^{53}Cr(p,d), and ^{53}Cr(p,p') experiments are used in conjunction with the weak-coupling model and the theoretical model calculations of Maxwell and Parkinson and of Ramavataram to discuss the structure of the low-lying levels of ^{53}Cr. (auth)

29947 QUASI-ELASTIC (p,n) SCATTERING FROM SCANDIUM AND TITANIUM ISOTOPES. Goodman, C. D. (Oak Ridge National Lab., Tenn.); Anderson, J. D.; Wong, C. Phys. Rev., 156: 1249-54(Apr. 20, 1967). (RONL-P-1904).

The differential cross sections have been measured for quasi-elastic (p,n) scattering on a sequence of targets ^{45}Sc, ^{46}Ti, ^{47}Ti, ^{48}Ti, ^{49}Ti, and ^{50}Ti which have neutron excesses from 2 to 6. Except for ^{47}Ti and ^{49}Ti, the cross sections are proportional to the neutron excess. The measured Q values for the reaction are interpreted as measurements of the Coulomb energy difference for the isobars. The results show that the effective charge radius increases less rapidly than $A^{1/3}$ as neutrons are added to the titanium isotopes. (auth)

29948 LEVEL STRUCTURE OF ^{45}Ca INVESTIGATED BY DEUTERON STRIPPING. Rapaport, J. (Univ., Chile, Santiago); Dorenbusch, W. E.; Belote, T. A. Phys. Rev., 156: 1255-65 (Apr. 20, 1967).

The level structure of ^{45}Ca below 6.3-MeV excitation was studied by the ^{44}Ca(d,p)^{45}Ca reaction. Twenty-eight of the observed 88 transitions showed stripping angular distributions and were analyzed in terms of the distorted-wave Born approximation to obtain l_n values and spectroscopic factors. A sum-rule analysis of the spectroscopic factors is given. A level at 1.886 MeV was excited by an $l_n = 2$ transition and is interpreted as a $1d^{-1}_{3/2}$ hole state in ^{45}Ca. This state is further discussed in terms of core excitation in ^{44}Ca. The observed ^{45}Ca level scheme is compared to calculated level schemes and to the level schemes of the ^{45}Sc and ^{47}Ti isotopes. (auth)

29949 (p,n) REACTION ON DEFORMED NUCLEI ^{25}Mg AND ^{26}Mg. Wong, C.; Anderson, J. D.; McClure, J. W.; Pohl, B. (Univ. of California, Livermore). Phys. Rev., 156: 1266-76 (Apr. 20, 1967). (UCRL-70101).

The ^{25}Mg(p,n)^{25}Al and ^{26}Mg(p,n)^{26}Al reactions to individual levels have been investigated to assess the applicability of a strong-coupling deformed isospin model in describing the "inelastic" (p,n) charge-exchange reaction. For nuclei in the rotational region, the model predicts a simple splitting of the quadrupole strength [obtained from the $0^+ \rightarrow 2^+$, $\Delta T = 0$, ^{26}Mg(p,n) transition] among the members of the $K = 5/2$ ground-state band in the ^{25}Mg(p,n)^{25}Al reaction. The measured cross section, excitation function, and angular distribution for the $5/2^+ \rightarrow 7/2^+$ transition in ^{25}Mg(p,n) are in fair agreement with the predictions of the deformed isospin model. The evidence for a quadrupole contribution to the $5/2^+$ ground state and $9/2^+$ excited state in ^{25}Mg(p,n) is inconclusive because of the presence of a large contribution to the cross section from spin–flip with charge exchange. As in a previous experiment, the measured $0^+ \rightarrow 2^+$, $\Delta T = 0$ cross section is much larger than the theoretical prediction of the deformed isospin optical model. However, the $0^+ \rightarrow 2^+$(p,n') cross sections are correlated with the analogous $0^+ \rightarrow 2^+$(p,p') cross sections. In the ^{26}Mg(p,n)^{26}Al reaction, the measured $0^+ \rightarrow 2^+$, $\Delta T = 0$ cross section is three times the $0^+ \rightarrow 0^+$ isobaric cross section. On the other hand, the $0^+ \rightarrow 0^+$, $\Delta T = 0$; $0^+ \rightarrow 1^+$, $0^+ \rightarrow 3^+$, and $0^+ \rightarrow 5^+$, $\Delta T = 1$ cross sections are comparable, indicating that charge exchange with spin-flip and with $\Delta l = 0$, 2, 4 is almost as important as monopole charge exchange in the ^{26}Mg(p,n)^{26}Al reaction. The observation of $K = 5/2$ to $K = 1/2$ band transitions, which are comparable to $K = 5/2$ to $K = 5/2$ transitions in ^{25}Mg(p,n), would seem to indicate that single-particle transitions are relatively more important when compared with the analogous (p,p') scattering, and thus that an appreciable fraction of the $K = 5/2$ to $K = 5/2$ ($J^\pi = 7/2^+$ or $9/2^+$) transition strength goes via single-particle matrix elements. It is concluded that a microscopic strong-coupling calculation, in which the charge–exchange part of the two-body interaction includes spin-flip and angular-momentum transfers up to $\Delta l = 4$, is needed to explain the measurements. (auth)

29950 PROTON-HOLE STATES IN ^{47,45}K. Bjerregaard, J. H.; Hansen, O.; Nathan, O.; Stock, R. (Univ. of Copenhagen). Phys. Lett., 24B: 568-70(May 29, 1967).

Proton-hole states in ^{45}K and ^{47}K were excited by the ^{46,48}Ca(t,α) reactions. The α-particle angular distributions for the transitions to ^{45}K(0) and ^{47}K(1) are similar and those to ^{45}K(1) and ^{47}K(0) are similar. It is concluded that the ^{47}K ground state has $J^\pi = 1/2^+$ rather than $3/2^+$. (auth)

29951 ENERGY LEVELS OF ^{54}Co AND ^{58}Cu. Cookson, J. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Phys. Lett., 24B: 570-3(May 29, 1967).

The energy levels below about 2.2 MeV in ^{54}Co and ^{58}Cu were observed in time-of-flight measurements of the neutrons from the (p,n) reactions on ^{54}Fe and ^{58}Ni. The level schemes are considered in relation to simple shell model theory, and the relative cross sections for production of the (0^+, T = 1) and (1^+, T = 0) final states are discussed. (auth)

29952 TWO-PARTICLE-ONE-HOLE STATES OF ^{41}Ca AND ^{41}Sc. Armigliato, A.; El-Nadi, L. M.; Pellegrini, F. (Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim. (10), 49B: 142-4(May 11, 1967).

The expected energy positions and spins of the two-particle–one-hole (2p-1h) states belonging to the $(1d_{3/2})^{-1}(f_{7/2})^2_J$ configuration in the ^{41}Ca and ^{41}Sc nuclei are reported. (S.F.L.)

29953 STRUCTURE OF THE GIANT RESONANCE IN MEDIUM SPHERICAL NUCLEI. Costa, S. (Univ., Turin, Istituto Nazionale di Fisica Nucleare, Turin); Ferrero, F.; Manfredotti, C.; Pasqualini, L.; Piragino, G.; Arenhoevel, H. Nuovo Cim. (10), 48B: 460-2(Apr. 11, 1967).

The dynamical theory of the collective model predicts that the main E1 mode for the vibrational nuclei Ti and Zn splits into several states with appreciable dipole strength. Measurements of the total photoneutron emission from Ti and Zn confirmed that many of the essential features of the (γ,2n) cross sections for these nuclei can be explained by the collective model. (S.F.L.)

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Refer also to abstracts 29833, 29879, 29893, 29908, 29913, 29938, 29941–29943, 30020, 30021, 30075, 30076 and 30078.

29954 (AAEC/E–172) PROMPT NUBAR MEASUREMENTS FOR THERMAL NEUTRON FISSION. Boldeman, J. W.; Dalton, A. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1967. 40p. Dep.

The number of prompt neutrons ($\bar{\nu}$) produced in the thermal neutron-induced fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu was determined with high accuracy using the liquid scintillator technique. Measurements were made relative to an assumed value of $\bar{\nu}$ = 3.784 for the spontaneous fission of ^{252}Cf. The present results are compared with previous measurements. (auth)

29955 (AAEC/TM–362) COMPARISON OF RESONANCE ABSORPTION THEORY USED IN THE CODES GYMEA AND PEAS AND EVALUATION OF RESIDUAL BACKGROUND REACTION RATES. Cook, J. L.; Wall, A. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1966. 46p. Dep.

Details of the neutron resonance theory used in the code GYMEA are described and compared with exact solutions for resonances in ^{232}Th, ^{235}U, and ^{240}Pu. The relative merits of two methods for including background cross sections are evaluated by an exhaustive study of the reaction rates across the resonances. It was found that the analytical procedure for calculating resonance reaction rates leads to tolerable errors in reactor physics calculations. The resonance-adjusted calculations emerged as the most accurate method for computing the fine structure of the reaction rates across a resonance. (auth)

29956 (AE–278) ON THE $D_{\frac{5}{2}} \rightleftharpoons G_{\frac{9}{2}}$ TRANSITIONS IN ODD MASS Pm NUCLEI. Backlin, A.; Malmskog, S. G. Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1967. 18p. Dep.

The half lives of the first excited levels in ^{145}Pm and ^{147}Pm were measured by the delayed coincidence method and are 2.69 ± 0.08 and 2.51 ± 0.05 nsec, respectively. From a measurement of the L-subshell ratios of the 61-keV transition in ^{145}Pm, and E2 admixture of 0.15 ± 0.05% was obtained. The transition energy was found to be 61.25 ± 0.05 keV. The experimental reduced E2 transition probabilities from the first excited states to the ground states of ^{145}Pm, ^{147}Pm, and ^{149}Pm were compared to the theoretical predictions of Sorensen. (auth)

29957 (BMwF-FBK-67-15) ELEKTRONENPOLARISATION UND ZEITUMKEHR BEIM β-ZERFALL DES RaE. (Electron Polarization and Time Reversal in Nuclear β-Decay of RaE). Dierker, J. (Erlangen Univ. (West Germany). Physikalisches Institut). Feb. 1967. 32p. (In German). Dep.

In order to get more information about time reversal in nuclear β decay of RaE, the longitudinal β polarization was measured relative to ^{60}Co down to 60 keV, using Mott scattering after deflection in a spherical electrostatic field. At all energies investigated, the electrons were accelerated before scattering up to 150 keV. Using all polarization measurements and the spectrum shape measurement by Daniel in connection with Bühring's screening corrections, the time reversal phase Θ, defined by $C_A/C_V = -1.2\ e^{i\Theta}$, was determined to be $\Theta = 0 \pm 3^0$ in accordance with time reversal invariance. (auth)

29958 (BNL–11426) LEVEL STRUCTURE OF ^{190}Os. Mariscotti, M. A.; Kane, W. R. (Brookhaven National Lab., Upton, N. Y.); Emery, G. T. (Indiana Univ., Bloomington). May 25, 1967. 15p. (CONF-670414–2). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

The energy levels of ^{190}Os were studied using thermal neutron capture by ^{189}Os. High- and low-energy spectra were obtained using Ge(Li) detectors and a Ge–NaI combination for two-dimensional coincidence experiments. Gamma intensities were determined together with level parities, positions, and spins. A level scheme is proposed. (D.C.W.)

29959 (IAN-F–2) SECCIONES EFICACES PARA LAS REACCIONES INDUCIDAS POR DEUTERONES SOBRE RODIO. (Effective Cross Sections for Deuteron Induced Reactions in Rhodium). de Betancourt, I.; Nassiff, S. J. (Instituto de Asuntos Nucleares, Bogota (Colombia)). Apr. 1966. 14p. (In Spanish). Dep. mn.

The cross sections for the nuclear reactions $^{103}Rh(d,t)^{102}Rh$, $^{103}Rh(d,2p)^{103}Ru$, and $^{103}Rh(d,2n)^{103}Pd$ were determined experimentally. The deuteron energy in the incident beam was 27.5 MeV. The stack foil technique was used in order to reduce the energy down to the values corresponding to the threshold. (tr-auth)

29960 (IN–1026) NEUTRON TOTAL AND ABSORPTION CROSS SECTIONS OF ^{239}Pu. Young, T. E.; Simpson, F. B.; Bereth, J. R.; Coops, M. S. (Idaho Nuclear Corp., Idaho Falls). Mar. 1967. Contract AT(10-1)-1230. 81p. Dep. CFSTI.

The neutron total cross section of ^{239}Pu was measured from 0.008 to 6500 eV. These data give single-level Breit-Wigner parameters for resonances below 200 eV. The observed total cross section at 2200 m/sec is 588 barns. A value of 532 barns was calculated for the effective (equivalent 1/v) thermal absorption cross section. Parameters of individual resonances below 200 eV and average parameters at higher energies give a resonance absorption integral of 164 ± 15 barns, and a value of 1.10 ± 0.20 × 10^{-4} for the s-wave neutron strength function (Γ_n^0/D). (auth)

29961 (INR–772/I/1A/PL) THE FISSION OF ^{197}Au BY 13.4-MeV DEUTERONS. Natanson, L.; Decowski, P. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 7p. Dep.

The method of fragment detection in mica was used for the investigation of the reaction $^{197}Au(d,f)$ with 13.4-MeV deuterons. The number of fragments observed corresponded within experimental errors to the expected effect of U contamination of the Au sample which was tested in a separate experiment with reactor neutrons. The upper limit of the Au fission cross section is estimated to be 10^{-34} cm^2. (auth)

29962 (NAA-SR–11980(Vol.5)) EVALUATION OF CROSS SECTIONS AND RESONANCE PARAMETERS FOR ^{238}U, ^{233}U, ^{239}Pu, AND ^{241}Pu BETWEEN Cd-CUTOFF AND 10 keV. Hennies, H. H. (Atomics International, Canoga Park, Calif.). May 25, 1967. Contract AT(04-3)-701. 60p. Dep. CFSTI.

Fission and capture cross sections between Cd-cutoff and 10 keV were evaluated for the fissile isotopes, based on the available experimental differential cross sections, capture-to-fission ratios, and total fission and capture resonance integrals. Data available before December 1966 were considered. Several earlier evaluations such as the 1965 edition of BNL-325 were compared with more recent data. As a result of this evaluation, it is felt that even for the most intensively studied nucleus, U-235, the uncertainties in the fission cross section are about ±5%, and in the capture cross section ±20%. For Pu-239, σ_f is known to ±10% and σ_c to ±25%. For U-233 and Pu-241, the uncertainty in σ_f is ±15% and in σ_c ±30%. Different sets of resonance parameters for the resolved resonances, which are recommended in BNL-325 or by other research laboratories, were compared by calculating infinitely dilute total and partial resonance integrals. Calculations were performed with the resonance integral code TRIX-I, which is based on the single-level Breit-Wigner model. Average parameters for the unresolved resonances were extrapolated from resolved resonance parameters. Calculated partial resonance integrals, using these parameters, were compared with integrated measured cross sections where these are available. If necessary, the resonance parameters were slightly modified to give a better representation of the cross sections. Since published capture cross-section measurements do not exist for the keV-resonance-region of U-233, Pu-239, and Pu-241, these cross sections were calculated with the determined average parameters and appropriate statistical distributions. (auth)

29963 (NASA-TN-D-3991) ELASTIC AND INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES FROM EVEN TELLURIUM ISOTOPES. Leonard, Regis F.; Stewart, William M.; Baron, Norton (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 30p. CFSTI.

Angular distributions were measured for alpha elastic and inelastic scattering with isotopically enriched targets of tellurium-122, -124, -126, -128, and -130 by using the 42-MeV alpha beam of the NASA 60-inch cyclotron. In each isotope, three excited states exhibited relatively large cross sections. These were the one-phonon quadrupole state, the two-phonon state with spin and parity 4^+, and the one-phonon octupole state. Several other states were excited in each isotope but with cross sections that were too small to allow determination of very reliable excitation energies or differential cross sections. The elastic angular distributions were analyzed by using the optical model with a four-parameter Woods–Saxon potential and the Blair sharp cutoff model. Optical-model fits have been obtained for a wide range of values of optical-model parameters. All potentials that give a satisfactory fit to the experimental data are nearly identical at their outer edges, although they vary widely in the interior of the nucleus. Sharp-cutoff fits are typical of the type usually obtained. Inelastically scattered groups of alpha particles were analyzed by using a distorted-wave Born approximation (DWBA). These calculations yield excellent shape fits to the inelastic differential cross sections and allow the determination of deformation parameters that are in agreement with those measured by other methods. (auth)

29964 (NP-16668) PHENOMENOLOGICAL ANALYSIS OF ROTATIONAL STATES IN DEFORMED EVEN-EVEN NUCLEI. Abecasis, S. M.; Bosch, H. E.; Heras, C. A. (Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina)). Dec. 1966. 10p. Dep.

A comparison of the rotation-vibration and the asymmetric rotor (with vibrations) models with recent experimental data on some rare-earth nuclei is made. For the three lowest rotational bands, good agreement with experiment is obtained. The approximate equivalence between the two models is corroborated. The consistency with calculations based on microscopic theories is also achieved. (auth)

29965 (NYO-2807-29) APPROXIMATION FOR ELECTRONIC ENERGY LOSS BY FISSION FRAGMENTS. Mulas, Pablo (Instituto Politecnico Nacional, Mexico City); Axtmann, Robert C. (Princeton Univ., N. J.). [1966]. Contract AT(30-1)-2807. 4p. (CONF-670602-3). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The energy-distance relation $E/E_0 = (1 - x/R_e)^2$ for fission-fragment energy loss where electronic stopping is predominant is investigated. In this equation E is the average energy of fragments of initial energy E_0 which has penetrated a distance x, and R_e is an electronic range which has appropriate limits. Predictions of the equation are compared with experimental data on ^{235}U fission fragments in the gases H_2, He, air, carbon dioxide, Ne, and Ar. (S.F.L.)

29966 (UCRL-14000) THRESHOLDS FOR NEUTRON-INDUCED REACTIONS. Howerton, R. J.; Braff, Donald; Cahill, W. J.; Chazan, Nanette (California Univ., Livermore. Lawrence Radiation Lab.). May 1964. Contract W-7405-eng-48. 38p. Dep. CFSTI.

This tabulation of thresholds for neutron-induced reactions, in the laboratory system, was derived from the tabulation of binding energies given by König et al. No error analysis was attempted since it is felt that persons wanting a detailed analysis should properly consult König et al., and the references contained therein. This tabulation is primarily for those who need a ready reference. The definition of the threshold used here is: the minimum kinetic energy of an impinging neutron (in the laboratory system) such that the reaction is energetically possible. In view of this definition, all reactions having a positive Q-value have a threshold of zero. Those reactions having a negative Q-value have a threshold of $-[(A + 1)/A]Q$. For those reactions for which the binding energy of the residual nucleus is not given in König et al., dashes are entered in the table. (auth)

29967 (UCRL-14003) THRESHOLDS FOR TRITON-INDUCED REACTIONS. Howerton, R. J.; Braff, Donald; Cahill, W. J.; Chazan, Nanette (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 3, 1964. Contract W-7405-eng-48. 48p. Dep. CFSTI.

This tabulation of thresholds for triton-induced reactions, in the laboratory system, was derived from the tabulation of binding energies given by König et al. No error analysis was attempted since it is felt that persons wanting a detailed analysis should properly consult König et al., and the references contained therein. This tabulation is primarily for those who need a ready reference. The definition of the threshold used here is: the minimum kinetic energy of an impinging neutron (in the laboratory system) such that the reaction is energetically possible. In view of this definition, all reactions having a positive Q value have a threshold of zero. Those reactions having a negative Q value have a threshold of $-[(A + 3)/A]Q$. For those reactions for which the binding energy of the residual nucleus is not given in König et al., dashes are entered in the table. (auth)

29968 (UCRL-14006) THRESHOLDS FOR GAMMA-INDUCED REACTIONS. Howerton, R. J.; Braff, Donald; Cahill, W. J.; Chazan, Nanette (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 14, 1964. Contract W-7405-eng-48. 48p. Dep. CFSTI.

This tabulation of thresholds for gamma-induced reactions, in the laboratory system, was derived from the tabulation of binding energies given by König et al. No error analysis was attempted, since it is felt that persons wanting a detailed analysis should properly consult König et al., and the references contained therein. This tabulation is primarily for those who need a ready reference. The definition of the threshold used here is: the minimum energy of an impinging photon (in the laboratory system) such that the reaction is energetically possible. In view of this definition, all reactions having a positive Q value have a threshold of zero. Those reactions having a negative Q value have a threshold of $-Q$. For those reactions for which the binding energy of the residual nucleus is not given in König et al., dashes are entered in the table. (auth)

29969 (UCRL-17299) NUCLEAR CHEMISTRY DIVISION ANNUAL REPORT, 1966. Cunningham, B. B.; Reynolds, F. L.; Stephens, F. S. (eds.) (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1967. Contract W-7405-eng-48. 419p. Dep. CFSTI.

29970 (WANL-TME-1586) A SINGLE LEVEL ANALYSIS OF ^{235}U BASED ON RECENT σ_t, σ_f, AND σ_c MEASUREMENTS; A n + ^{235}U MULTIGROUP CROSS SECTION LIBRARY. Gibson, Gordon (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Mar. 1967. Contract SNP-1. 143p. Dep. CFSTI.

Total, capture, and fission neutron cross-section data for ^{235}U were simultaneously fit with a single-level Breit-Wigner least squares analysis. Two sets of resonance parameters for E < 63 eV are presented. One set was obtained when unit weighting was used in the least-squares analysis, and another set was obtained when weighting proportional to the inverse of the cross section was used. The resonance capture and fission integrals calculated from the parameters agree in each case to within three percent with corresponding direct numerical integration of the data. The effects of simultaneously fitting two cross sections at a time: total and fission, and capture and fission were also studied. Two n + ^{235}U multigroup cross section libraries, that differ only in the resonance range where the two sets of resonance parameters described above are used, were generated for use in reactor calculations. The ratio of the capture resonance integral to the fission resonance integral that is calculated ($\bar{\alpha} = 0.51$) with either library agrees with the reactor integral measurements ($\bar{\alpha} = 0.50 \pm 0.02$). These libraries are presented. (auth)

29971 PARAMETERS FOR THE FIRST NEUTRON RESONANCE IN ^{113}Cd. Akyuez, R. Oe.; Cansoy, C.; Domanic, F. (Cekmece Nuclear Research and Training Center, Istanbul). Nucl. Sci. Eng., 28: 359-63(June 1967).

The total neutron cross section of ^{113}Cd was measured in the energy range from 0.025 to 1 eV with a crystal spectrometer using the Be(10$\bar{1}$1) and NaCl(200) crystal planes as monochromators. A new method for second-order correction was applied, and the resonance at 0.181 eV was fitted to a Breit-Wigner single-level formula by the method of least squares. The resonance parameters obtained from the analysis are $E_0 = 0.181 \pm 0.003$ eV, $\sigma_0 = 7847 \pm 187$ b, $\Gamma = 0.1087 \pm 0.0033$ eV, and $\Gamma_n = (0.0791 \pm 0.0032) \times 10^{-3}$ eV assuming that the statistical weighing factor is $g = 3/4$. (auth)

29972 ENERGY LEVELS OF ^{193}Ir. Perry, Frank C.; Murphy, E. Smith Jr. (Washington State Univ., Pullman). Nucl. Phys., A99: 497-506(1967).

The gamma radiations from ^{193}Ir were investigated using a Ge(Li) detector, scintillation detectors and coincidence techniques. The ^{193}Os source was obtained by neutron irradiation of enriched ^{192}Os. Numerous gamma-ray transitions and gamma-gamma coincidences were observed. The decay scheme for ^{193}Ir proposed from these data postulates the existence of levels at 73, 139, 180, 280, 358, 362, 461, 558, 559, 657, 713, 799, and 874 keV. Spin and parities were tentatively assigned to several of the levels of ^{193}Ir. (auth)

29973 THE DETERMINATION OF THE STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES IN ^{126}Te AND ^{128}Te BY COULOMB EXCITATION. Stokstad, R. G.; Hall, I. (California Inst. of Tech., Pasadena). Nucl. Phys., A99: 507-21(1967).

Measurements of the probabilities for Coulomb excitation of the first 2^+ states in ^{126}Te and ^{128}Te were made with ^4He and ^{16}O ions. The deviations observed from first-order perturbation theory are interpreted in terms of the static electric quadrupole moments Q_2 of the first 2^+ states of the two nuclei. The values of these static quadrupole moments in units of e·b are found to lie in the range $-0.16 > Q_2 > -0.50$ for ^{126}Te and $-0.01 > Q_2 > -0.40$ for ^{128}Te. (auth)

29974 ON THE EXISTENCE AND DECAY OF ^{149}Pr. Van Klinken, J.; Taff, L. M. (Ames Lab., Iowa). Contract W-7405-eng-82. Nucl. Phys., A99: 473-80(1967). (IS-1538).

The existence of 2.3-min ^{149}Pr was confirmed by studies of sources produced by $^{150}Nd(\gamma,p)$. Gamma rays were observed at 110, 139, 165, 742, and possibly 578 keV. The total disintegration energy is 3.0 ± 0.2 MeV. There is evidence for a beta-ray branch of ^{149}Pr to the ground state of ^{149}Nd with log ft = 5.9 ± 0.3. A decay scheme is proposed. (auth)

29975 THE DECAY OF ^{139}Pr. King, J. D.; Neff, N.; Taylor, H. W. (Univ. of Toronto). Nucl. Phys., A99: 433-41(1967).

The decay of 4.9-hr ^{139}Pr was studied with a Ge(Li) detector and a 4096-channel, pulse-height analyzer. Nine gamma transitions were identified with certainty with two additional transitions being somewhat uncertain. Levels in ^{139}Ce were established at 254.7, 1347.4, 1575, 1598, 1630.5, 1818, and 1905 keV. The level sequence is compared to shell-model predictions. (auth)

29976 THE DECAY OF ^{147}Nd. Jacobs, E.; Heyde, K.; Dorikens, M.; Demuynck, J.; Dorikens-Vanpraet, L. (Rijksuniversiteit, Ghent. I.N.W. Proeftuinstraat, Ghent). Nucl. Phys., A99: 411-20(1967).

The decay of ^{147}Nd was investigated by beta-gamma (detectors of plastic and NaI) and gamma-gamma (detectors of Ge and NaI) coincidence techniques, in a multiparameter setup. Besides the well-known beta-ray groups, the components with end-points energies 410 keV and 490 keV were found. The existence of 77-keV and 154-keV gamma transitions in ^{147}Pm was proved. No evidence could be found for levels of about 723 keV or 182 keV. The experimental level scheme is compared to a theoretically calculated one. (auth)

29977 PRECISE MEASUREMENTS, IN THE REGION OF SYMMETRIC MASS, OF THE KINETIC ENERGY OF FRAGMENTS FROM THERMAL FISSION OF ^{235}U. Signarbieux, C.; Ribrag, M.; Nifenecker, H. (CEN, Saclay, France). Nucl. Phys., A99: 41-54(1967). (In French).

Energy correlation experiments with fission fragments are strongly perturbed by false events in the symmetric region. It is shown that the measurement of an additional parameter, namely the difference in time-of-flight between the fragments, enables one to eliminate these difficulties. For thermal fission of ^{235}U, values of mass yields in the symmetric region are found to agree quantitatively with radiochemical values. Moreover, the average total kinetic energy as a function of the pre-neutron-emission mass has been calculated. This curve presents a large dip at symmetry with a maximum to minimum difference of 21.2 ± 0.8 MeV, which is smaller than previously published results. (auth)

29978 REACTIONS BETWEEN PROTONS AND COMPLEX HEAVY NUCLEI AT 30 TO 155 MeV. Le Beyec, Y.; Lefort, M. (Univ., Paris, Orsay, France). Nucl. Phys., A99: 131-60(1967). (In French).

Excitation functions were established between 20 and 156 MeV for twelve (p,xn) reactions and nine (p,pxn) reactions induced on Bi by protons. In order to determine the cross sections for light polonium isotopes, new identifications were made for the disintegration schemes on ^{197}Po to ^{202}Po. New isomeric states were found for ^{203}Po, ^{201}Po, ^{199}Po, and ^{197}Po. The experimental excitation functions were compared with theoretical values which were deduced from the two-step mechanism (Serber model). It was shown that the experimental data are in agreement with a direct-interaction model in which prompt cascades are calculated in a diffuse-edge nucleus. However a model in which reflections and refractions are included for the penetration and the exit of the prompt nucleons, yields much too high proportions of compound nucleus, and therefore a simple model in which the impulse approximation is strictly applied for all collisions is a better description of the direct-interaction process than more elaborate calculations. The de-excitation process is described with great success by the statistical theory in which, at each step of the neutron evaporation chain, a competition is introduced for charged-particle evaporation and for fission. The best fit is obtained with level density parameters $a = 13\ MeV^{-1}$ for the particle emission and $a_f = 13.5\ MeV^{-1}$ for fission. The agreement with experimental data obtained for all excitation functions along such a large energy range (20 to 155 MeV) seems to be a great success of the Serber-Goldberger model for the description of medium-energy nuclear reactions. (auth)

29979 DECAY OF ^{195m}Au, ^{195m}Hg, AND ^{195}Hg. Frank, Karl Heinrich (Univ., Goettingen, Ger.). Z. Phys., 203: 71-81(1967). (In German).

The γ radiation of ^{195m}Au, ^{195m}Hg, and ^{195}Hg was measured using a Ge(Li) semiconductor detector. Conversion coefficients of most transitions could be determined from the measured γ intensities and from already known electron intensities. Spin and parity of the corresponding levels and log ft values for the decay of ^{195}Hg and ^{195m}Hg were determined. New γ energies (698, 754, and 852 keV) were found in the decay of ^{195m}Hg. With a coincidence method a value of $\alpha_{tot} = 13 \pm 3$ for the 61.5 keV radiation of ^{195m}Au was measured. (auth)

29980 ANGULAR CORRELATION OF CASCADE GAMMA RAYS IN ^{94}Nb. Kuebbing, R. A.; Casper, K. J. (Western Reserve Univ., Cleveland). Nucl. Phys., A98: 75-81(1967).

The directional correlation and polarization correlation of the 703-871 keV gamma ray cascade following the decay of 20,000 y ^{94}Nb were measured. On the basis of these measurements the spin and parity of the 1574 keV level in ^{94}Mo was determined as 4^+. (auth)

29981 THE LEVEL SCHEME OF ^{134}Ba. Raeside, D. E.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A98: 54-64(1967).

The gamma-ray spectrum associated with the beta decay of ^{134}Cs was studied with curved-crystal and Ge(Li) spectrometers. The data provide energy and intensity measurements of 11 gamma rays. Coincidence spectra were taken using a Ge(Li)-NaI(Tl) combination. The data fail to support the previously proposed levels at 1570 and 1773 keV. (auth)

29982 NUMBER AND ENERGY OF PROMPT NEUTRONS FROM ^{252}Cf AND ^{235}U FISSION AS A FUNCTION OF THE FISSION PRODUCT MASS. Dmitrieva, I. K. (Inst. of Nuclear Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 41-6(1967). (In Russian).

Most of the neutrons are emitted by the lighter fission fragment from fission into two almost equal fragments. The minimum number of neutrons is emitted by fission fragments which have a magic number or are close to a magic number. An attempt is made to claculate quantitatively the excitation energy as a function of the fission product mass. It is assumed that almost all the initial fission product energy is deformation energy which is converted to excitation energy of the fission fragments after the fission event. For ^{235}U the excitation energy has a maximum at $A_1 = A_2$ (A_1 and A_2 are the fission product masses), and a minimum at $A_1/A_2 = 1.2$ to 1.3. For ^{252}Cf the excitation energy varies very slightly with a change in A_1/A_2, has a slight minimum at $A_1 = 140$, and increases slowly with an increase in A_1/A_2. Numerical calculations are carried out for the spontaneous fission of ^{252}Cf and thermal fission of ^{235}U. The calculated number of prompt neutrons and the calculated distribution of excitation energy between the fission fragments agree well with experiment. (TTT)

29983 EVIDENCE OF THE EFFECT OF EXTRA-NUCLEAR FIELDS ON THE ANISOTROPY IN THE CASE OF ^{170}Tm CHLORIDE. Ambrosino, Georges; Lachkar, Jean (Laboratoire Maurice de Broglie, Bretigny-sur-Orge, France). Compt. Rend., Ser. A and B, 264: 487-90(Feb. 6, 1967). (In French).

The β-γ angular correlation of the cascade $(1^- \rightarrow 2^+ \rightarrow 0^+)$ of ^{170}Tm was studied, and its variation with energy was determined. The mean life of the excited level of ^{170}Yb was measured to be 2.3 nsec. This involves an attenuation of the angular correlation which was shown in the case of a source of $^{170}TmCl_3$. This attenuation is due to a hyperfine structure coupling between the residual nucleus and its ionized electron cortege. (tr-auth)

29984 β SPECTRUM OF THE $1^- \rightarrow 2^+$ TRANSITION OF ^{170}Tm. Andre, Stephane; Depommier, Pierre; Liaud, Pierre; Millies-Lacroix, Jean-Claude (Univ., Grenoble, France. Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 264: 819-21(Mar. 6, 1967). (In French).

The β spectrum of the $1^- \rightarrow 2^+$ transistion of ^{170}Tm was measured in coincidence with the 84-keV γ ray. The form factor obtained is well expressed by the modified B_{ij} approximation for $Y^2 \sim 0.3$. (tr-auth)

29985 ELASTIC SCATTERING OF 23-MeV ALPHA PARTICLES BY XENON. Renuart, J.; Macq, P. C. (Univ., Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. 1, 81: 69-74(1967). (In French).

The sharp cut-off model is applied for the elastic scattering of alpha particles on xenon nuclei, and the quarter rule was used to determine the radius of this nucleus. Measurements were made using a gaseous target. The differential cross section is shown as a function of the scattering angle, and the agreement of the Blair differential cross section and the cross section for Coulomb scattering is also shown. (J.F.P.)

29986 LEVELS AND TRANSITIONS IN ^{187}Re. Bashandy, E.; El-Sayad, G. M.; El-Aassar, M. R.; Migahed, M. (Atomic Energy Establishment, Cairo). Atomkernenergie, 12: 59-69(Jan.-Feb. 1967).

The decay of ^{187}W was investigated by the use of high-resolution double-focusing beta-ray spectrometers for the measurements of the conversion electron and beta spectra. In addition to gamma rays previously reported, 22 new gamma rays of energies 35.60, 138.32, 143.88, 151.46, 167.99, 173.31, 188.90, 197.30, 201.14, 211.64, 220.71, 223.12, 225.63, 252.20, 302.18, 437.51, 466.94, 473.76, 478.23, 601.15, 735.59, and 759.60 keV were observed. Energies of the strongest lines were measured absolutely by means of an iron free double focusing instrument, and further energy determinations were made relatively to these lines. The standard error of the measurements was frequently as low as 2 parts in 10^4. A complete set of energy sums was computed in order to survey the possibilities of cascade-crossover combinations. Conversion coefficients were obtained by normalizing the ratios of conversion and photon intensities with respect to the 480 keV E 2 transition in ^{187}Re. Multipolarity information was thus obtained for 38 transitions by comparing the observed internal conversion coefficient or conversion line intensity ratios with

the theoretical values calculated by Sliv and Band. The mixing ratio E2/M1 of some gamma transitions were determined on the basis of internal conversion coefficients. Three negatron components of maximum energies 1330 ± 5, 629 ± 6 and 323 ± 5 keV and of relative abundance 18.3%, 73.8% and 7.8% respectively, were found. The log ft values of the beta decay from the ground state of ^{187}W to levels of ^{187}Re were obtained. The spins and parities of the excited states of ^{187}Re were assigned. A few modifications on the previously reported level scheme of ^{187}Re are proposed on the basis of the energy data. The most important alteration is the addition of excited levels of energies, 302, 400, 437, 601, 735, 750, 760, 878, 911, and 947 keV. (auth)

29987 INVESTIGATION OF SHAKE-UP OF THE ELECTRON SHELL IN β DECAY OF ^{203}Hg. Berlovich, E. E.; Kutsentov, L. M.; Fleisher, V. G. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 426-34(Mar. 1966). (In Russian).

The autoionization effect for ^{203}Hg is investigated on the basis of direct detection of low-energy electrons corresponding to shake-up of the outer electron shells. For isotopes that are not pure β emitters it is necessary to discriminate the electrons associated with rearrangement of the shells incident to conversion. The experimental method and results are described. (L.B.S.)

29988 NEW DATA ON THE CONVERSION ELECTRON SPECTRUM FOR THE STRONGEST TRANSITIONS IN ^{170}Yb. Balalaev, V. A.; Dzhelepov, B. S.; Medvedev, A. I.; Uchevatkin, I. F.; Shestopalova, S. A. (All-Union Scientific Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 413-15(Mar. 1966). (In Russian).

The availability of a new higher energy source made it possible to study conversion electrons having energies above 3150 keV. The reference used was the K-conversion line of the transition 2955.2 keV. The spectrum from 2880 to 3150 keV was remeasured to confirm those made above 3150, since the spectrum is complex and the K, L, and M lines of the various transitions overlap. Results of measurements above 3150 keV, given in a table, are essentially new. Six new transitions were found: 3224, 3245, 3263, 3287, 3302 and 3325. The latter is suggested as possibly the strongest transition in the spectrum. (JPRS)

29989 γ SPECTRUM OF ^{140}La AT ENERGIES FROM 300 TO 1610 keV. Dzhelepov, B. S.; Zhukovskii, N. N.; Maloyan, A. G.; Prikhodtseva, V. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 403-6 (Mar. 1966). (In Russian).

New studies were carried out on the gamma spectrum of ^{140}La with an electron having a resolution of $\Delta H \rho/H \rho = 1.2\%$ (at 1 MeV) in the range of 300 to 1610 keV. The gamma-ray source was a lanthanum oxide target irradiated with thermal neutrons. Curves plotted of the overall spectrum and of the region of interest are shown. New weak transitions are clearly observed at 434 and 726 keV. The 635-keV line observed by other authors was not seen and is assumed to have an intensity of less than 1.0% per decay. Detailed studies are not made in the range of 970 to 1500 keV, so the new weak transitions previously reported in the literature at 1088, 1120, 1415, and 1680 keV are not confirmed but are assumed to have an intensity of less than 0.3% per decay. (JPRS)

29990 γ RADIATION OF ^{156}Eu AT ENERGIES FROM 600 TO 2400 keV. Dzhelepov, B. S.; Dmitriev, A. G.; Zhukovskii, N. N.; Maloyan, A. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 394-402 (Mar. 1966). (In Russian).

The gamma spectrum of ^{156}Eu was studied in the energy range of 600 to 2400 keV with a magnetic spectrometer. An enriched sample of ^{153}Eu was irradiated with thermal neutrons (2×10^{14} cm^{-2}/sec) for 1000 hours, then aged 200 days. The ^{156}Eu spectrum was obtained by subtracting the spectrum of $^{152+154}$Eu. The recoil electron spectrum is plotted for the entire range of energies and the most probable decay scheme is shown. Results of measured relative gamma-ray intensities are compared with those of other authors. Methods used are shown to be more accurate than those of other authors. Four new gamma transitions are introduced: hν = 907, 943, 1028, and 1686 keV. The schemes for these transitions are discussed. (JPRS)

29991 SPIN OF ^{170}Lu. Dzhelepov, B. S.; Zaitseva, N. G.; Kraft, O. E.; Naumov, Yu. V.; Sigalov, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 554-9(Mar. 1966). (In Russian).

The positron–gamma coincidence method is used to determine the spin of ^{170}Lu which has a positron decay to the lower rotational band of ^{170}Yb. The ^{170}Lu sample was obtained from ^{170}Hf, with the usual bombardment of a tantalum target with 660 MeV protons. The coincidences of ~1660 keV positrons and gamma radiation were studied in the range of 10 to ~250 keV. Coincidences were not observed at energies of 193 and 84 keV, nor were positron transitions from the ^{170}Lu ground state to the 2^+ and 4^+ levels of ^{170}Yb. It is shown that the ground state spin of ^{170}Lu is zero–a conclusion that is supported by theoretical arguments. Finally, the purity of the isotopic spin in the ground state of ^{170}Lu is determined. The coefficient of impurity isospin (5×10^{-3}) determined theoretically is 20 times greater than the experimental value. (JPRS)

29992 DECAY OF ^{160}Ho. Avotina, M. P.; Grigorev, E. P.; Dzhelepov, B. S.; Zolotavin, A. V.; Sergeev, V. O. (Leningrad State Univ.). Izv. Akad. Nauk SSSR. Ser. Fiz., 30: 530-53 (Mar. 1966). (In Russian).

A continuation of work is reported on the decay of ^{160}Er + ^{160*}Ho + ^{160}Ho under improved conditions for studying the conversion electron spectrum. The study was carried out with two modernized, high-resolution, double focussing beta spectrometers: one with an equilibrium orbit of 140 mm; and the other, 500 mm. The ^{160*}Ho and ^{160}Ho samples were obtained from the isotope ^{160}Er. A tantalum target was irradiated by 660-MeV protons for 1.5 to 8 hrs. in a synchrocyclotron, and the rare earth group was separated chemically and then fractioned in a chromatographic column. Extensive information was gathered on the conversion electron spectrum of ^{160}Er + ^{160}Ho and is presented in a table which shows transition energies, conversion lines, I_e, multipolarity of the gamma transition, conversion coefficient, gamma ray intensity, total intensity of the transition, and position of the transition in the decay scheme. Detailed data are also given on many ^{160}Dy levels and transitions, and three rotational bands are established. Experimental results are compared with theory and the results of other authors. The multipolarity and intensity of the isomeric transition of ^{160}Ho is discussed, as well as the quantum characteristics of its levels, positron decay, and electron capture. (JPRS)

29993 EXCITATION OF A STATE AT 336 keV IN DECAY ^{169}Yb → ^{169}Tm. Dzhelepov, B. S.; Tishkin, P. A.; Shishelov, I. A. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 527-9(Mar. 1966). (In Russian).

The decay of ^{169}Yb → ^{169}Tm is studied for the purpose of discovering the ~336 keV energy state by the "electron-electron" coincidence method. The ^{169}Yb sample was extracted by chromotography from the lithium fraction of a tantalum target irradiated by 660 MeV protons for 5 hours in the Dubna synchrocyclotron. Measurements were made on a double toroidal beta spectrometer. A graph is shown of a portion of the coincidence spectrum of the 131 keV K-^{169}Tm conversion electrons. The intense coincidence peaks observed are identified as K, L, and M conversion lines of the 177 keV transition and (M + N) 131 and K198 spectrum of the conversion electrons. The relative intensities of the 177-keV K and L conversion electrons are not in agreement with the results of other authors. The K lines of the 131 and 198 keV transitions are discussed, and possible explanations are given. Results are compared with those of other investigators. (JPRS)

29994 DISINTEGRATION OF ^{6}Li. Bethge, K.; Meier-Ewert, K. (Univ., Heidelberg). Phys. Rev. Lett., 18: 1010-11(June 5, 1967).

The disintegration of ^{6}Li nuclei was measured on silver targets at 22 MeV (lab). The measured total cross section of 175 ± 30 mb has to be compared with a theoretical value of 96 mb. The elastic scattering of ^{6}Li on Ag shows a large contribution of nuclear absorption. (auth)

29995 PRECISE MEASUREMENTS OF MUONIC ISOTOPE SHIFTS FOR 29 NUCLIDES, IN PARTICULAR, FOR THE Ca ISOTOPES 40, 42, 44, and 48. Ehrlich, R. D. (Univ. of Chicago); Fryberger, D.; Jensen, D. A.; Nissim-Sabat, C.; Powers, R. J.; Telegdi, V. L.; Hargrove, C. K. Phys. Rev. Lett., 18: 959-62 (May 29, 1967).

Precise measurements of the isotope shift for muonic K transitions are reported for ^{28,29,30}Si, ^{40,41}K, ^{40,42,44,48}Ca, ^{54,56,57}Fe, ^{58,60,61,62}Ni, ^{63,65}Cu, ^{86,87,88}Sr, ^{90,92}Zr, and ^{116,117,118,119,120,122}Sn. The shifts ^{40}Ca–^{44}Ca and ^{40}Ca–^{48}Ca are of special interest, as they confirm the conclusions from electron scattering. The shifts ^{86}Sr–^{87}Sr and ^{86}Sr–^{88}Sr are found to be negative, indicating that the heavier isotope has a smaller charge radius. (auth)

29996 ISOTOPE SHIFT MEASUREMENTS USING K X RAYS IN Sn, Sm, AND W. Chesler, R. B.; Boehm, F.; Brockmeier, R. T. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 18: 953-6(May 29, 1967).

Electronic $K\alpha_1$ x-ray isotope shifts were measured for $^{116-124}$Sn, $^{148-154}$Sm, $^{182-184}$W, $^{184-186}$W, and $^{182-186}$W using a curved-crystal Cauchois spectrometer. The analysis of the measurements has included the volume effect, screening, normal and specific mass shifts, nuclear polarization, and electron magnetic moment interaction. (auth)

29997 ISOMER SHIFTS IN THE $2^+ \rightarrow 0^+$ ROTATIONAL TRANSITION OF ^{170}Yb. Atzmony, U.; Bauminger, E. R.; Hess, J.; Mustachi, A.; Ofer, S. (Hebrew Univ., Jerusalem). Phys. Rev. Lett., 18: 1061-3(June 12, 1967).

Mössbauer measurements of isomer shifts were carried out on the 84-keV $2^+ \rightarrow 0^+$ rotational transition of ^{170}Yb with the objective of measuring the difference in the mean-square charge radius between the 2^+ and 0^+ ground state rotational levels. The measurements were made at 4.2°K using a source of irradiated $TmAl_2$. The absorbers consisted of Yb metal, various intermetallic compounds, and salts with Yb ions of valancies 2^+ and 3^+. It was found that the maximum shift between 3^+ and 2^+ ions occurred between YbGa garnet and $YbSO_4$ and was +0.63 ± 0.10 mm/sec. The maximum shift between Yb metal and salts containing Yb^{2+} ($YbSO_4$) was +0.36 ± 0.10 mm/sec. The shift between all the 2^+ metallic compounds was zero within the accuracy of the measurements. (J.F.P.)

29998 CORRELATION BETWEEN α-PARTICLE ENERGY AND NUMBER OF γ QUANTA IN SPONTANEOUS TERNARY FISSION OF ^{244}Cm. Adamov, V. M.; Drapchinskii, L. V.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz., 5: 923-4 (Apr. 1967). (In Russian).

Previously V. M. Adamov et al. [Nuclear Physics, 5: 42(1967)] showed that the number of γ quanta from the spontaneous ternary fission of ^{244}Cm was not a function of the α particles in the 0.2 to 2.3 MeV energy range. An attempt was made to follow up with similar measurements for γ quanta in the energy range from 1 to 5 MeV. The method of measurements was identical to the previous work. Gamma quanta were recorded using a 60 × 60 mm^2 NaI(Tl) crystal. The spectra of α particles coinciding with γ quanta at various energies showed that the α-particle spectra tapered down with the rise of γ energies starting with the energy range 3 to 4 MeV. For the γ quanta in the 4 to 5 MeV energy range the half-width of α spectra determined along the curve slope was two-fold narrower than the α-spectrum half-width for γ quanta in the 1 to 2 MeV range. (R.V.J.)

29999 DECOUPLING PARAMETER IN THULIUM ISOTOPES. Feifrlik, V. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 501-3(Mar. 1966). (In Russian).

Calculations are made of the decoupling parameter for the $\frac{1}{2}^+$ [411] state in ^{167}Tm, ^{169}Tm, and ^{171}Tm, taking into account the interaction of the odd nucleon with nucleons of the even-even core. The analysis is carried out in the framework of finite Fermi systems. The deformation dependence on the decoupling parameter proves to be substantially different from the dependence obtained from calculation in the framework of the Nilsson scheme, when the interaction between quasiparticles is taken into account, and also improves the agreement with experiment. (L.B.S.)

30000 RADIOCHEMICAL DETERMINATION OF FISSION YIELDS FOR THE FISSION OF ^{232}Th BY PILE NEUTRONS. Bresesti, M.; Burei, G.; Ferrari, P.; Moretto, L. (CCR-EURATOM, Ispra, Italy). J. Inorg. Nucl. Chem., 29: 1189-96 (May 1967).

The fission yields of nine nuclides (eight belonging to the heavy mass region) for the fast fission of ^{232}Th by pile neutrons were determined using radiochemical techniques. The nuclides were ^{93}Y, ^{140}La, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{147}Nd, ^{149}Pm, ^{151}Pm, and ^{153}Sm. In preliminary experiments, the fission yields of six nuclides for the fission of ^{235}U by thermal neutrons were also measured. Comparison of the data obtained with data reported in the literature for the heavy mass region has permitted definition of the absolute fission yields of certain nuclides (7.64 ± 0.5% for ^{140}Ba, 7.05 ± 0.4% for ^{141}Ce, and 7.52 ± 0.5% for ^{144}Ce) with a precision sufficient for the utilization of these nuclides in the measurement of the fission rate of ^{232}Th for fast neutron spectroscopy. (UK)

30001 THE HALF-LIFE OF ^{113m}In. Okamura, H.; Ogawa, M.; Mito, A. (Osaka Univ.). J. Inorg. Nucl. Chem., 29: 1185-7(May 1967).

Radiochemically pure ^{113m}In was prepared for an accurate determination of its half life. The gamma rays were counted by a NaI scintillation spectrometer. The decay curves showed single component characteristics for more than 20 hr (i.e., 13 half lives). The half life of ^{113m}In was found to be 99.3 ± 0.2 min, which is lower than any of the values previously reported. (UK)

30002 THE HALF LIFE OF THE 619-keV ISOMERIC LEVEL OF ^{115}Sn. Ivanov, E. A.; Magda, M. I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 227-34(1967).

The half life of the $\frac{1}{2}^+$ state at 619 keV in ^{115}Sn was precisely measured by using a slow time-to-pulse-height converter. The value obtained, $T_{\frac{1}{2}}$ = 3.26 ± 0.08 μsec, corresponds to a retardation factor of 11 for the E2 transition depopulating the 619-keV level and is qualitatively accounted for by the Kisslinger and Sorensen model either in the single quasiparticle approximation or with quasiparticle-phonon mixtures. (auth)

30003 SURFACE DELTA INTERACTION AND COLLECTIVE E2 AND E3 TRANSITIONS IN RARE-EARTH NUCLEI. Faessler, Amand; Plastino, A. (Univ. of California, Los Angeles). Phys. Rev., 156: 1072-6(Apr. 20, 1967).

Gamma transition probabilities from the ground state into the γ-vibrational band and the K = 0 octupole vibrational band in even-mass rare-earth nuclei are calculated. The surface delta interaction (SDI) and the pairing-plus-quadrupole (PQF) or -octupole force (POF) are utilized as residual interactions. The quasi-particle random-phase approximation (QRPA) is employed in the calculation. Both residual interactions (SDI and PQF) give good agreement with experiment for electric quadrupole transitions, using an effective charge equal to Z/A. This value is required in a self-consistency argument given by Mottelson. For octupole transitions, good results are also obtained using the same effective charge. The Tamm-Dancoff approximation is compared with the RPA. It is shown that it does not yield reasonable results when used in this kind of calculation. (auth)

30004 THE DECAY OF 25-MINUTE ^{131}Te. Ahmed, N. (London Univ.). Nuovo Cim. (10), 48B: 447-51(Apr. 11, 1967).

An attempt was made to elucidate the spins of the 603- and 1147-keV levels of ^{131}I by γ–γ angular correlation measurements on the 150–453 and 150–997 keV cascades following the decay of ^{131}Te. The study confirms the possible spin allocations for the 603- and 1147-keV levels of earlier workers, deduced from transition intensity considerations. It is indicated that the 1147-keV level has spin $\frac{3}{2}$ and that the transition is practically pure E2 radiation with some 2% M1 mixture. The elimination of the previous alternatives of spin $\frac{5}{2}$ and $\frac{1}{2}$ for the 603-keV level was not accomplished. (S.F.L.)

30005 SECOND-ORDER VIRTUAL E1 TRANSITIONS IN COULOMB EXCITATION OF DEFORMED NUCLEI. Nebel, H.; Lin, D. L. (State Univ. of New York, Buffalo). Phys. Rev., 156: 1133-5(Apr. 20, 1967).

The possible effect of second-order virtual E1 transitions through the giant dipole resonance is investigated in connection with Coulomb excitation of deformed even–even nuclei. A comparison with the second-order reorientation effect shows that this E1 effect should not introduce any significant correction in a reorientation measurement of Q_{22}, the static quadrupole moment of the lowest 2^+ state. (auth)

30006 EMISSION OF LONG-RANGE ALPHA PARTICLES IN THE SPONTANEOUS FISSION OF ^{252}Cf. Fraenkel, Z. (Univ. of California, Berkeley. Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 156: 1283-1304(Apr. 20, 1967).

An experimental investigation of α-particle emission in the spontaneous fission of ^{252}Cf is described. The measured angular distribution and energy distribution of the α particles are presented, as well as the mass-ratio distribution of the fission fragments and the single-fragment energy distribution in fission accompanied by long-range α particles (LRA fission). Also shown is the angular distribution of the α particles as a function of the α-particle energy, the total fission-fragment energy, and the mass ratio. The experimental results show the LRA-fission process to be very similar to binary fission until the moment of scission. The angular distribution of the α particles as a function of the mass ratio (corrected for α-particle recoil) confirms the earlier conclusion that the scission point moves towards the light fragment as the mass ratio increases. The experimental results provide evidence that the α particle is emitted very close to the scission point and within 10^{-21} sec of the moment of scission. The angular distribution data support the model which explains the variation of the number of neutrons emitted in binary fission as a function of fragment mass on the basis of a variation in the nuclear deformation of the fission fragments at scission. (auth)

30007 KINETIC ENERGIES OF FRAGMENTS FROM SEVEN FISSION REACTIONS AT LOW EXCITATION ENERGIES. Bennett, Michael J.; Stein, William E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 156: 1277-83(Apr. 20, 1967). (LA-DC-8387).

This work describes a double-energy experiment performed with solid-state detectors on the thermal-neutron-induced fission of ^{233}U, ^{235}U, and ^{239}Pu; fast-neutron-induced fission of ^{231}Pa, ^{237}Np, and ^{238}U; and spontaneous fission of ^{252}Cf. Spectra of the fragment masses and energies were obtained. Average total kinetic energies and mean fragment masses for the fast-neutron-induced reactions are as follows: ^{231}Pa, 166.8 ± 2 MeV, 92.2 and 139.8 amu; ^{237}Np, 174.0 ± 2 MeV, 98.0 and 140.0 amu; and ^{238}U, 170.1 ± 2 MeV, 98.5 and 140.5 amu. The results are compared with recent time-of-flight and radiochemical data, where available. Average total kinetic-energy correlations with $Z^2/A^{\frac{1}{3}}$ are shown. (auth)

30008 SEMIMICROSCOPIC DESCRIPTION OF EVEN Cd SPECTRA. Alaga, C. (Zagreb Univ. Inst. Ruder Boskovic, Zagreb); Krmpotic, F.; Lopac, V. Phys. Lett., 24B: 537-9 (May 29, 1967).

A qualitative description of the properties of the low-lying

states of Cd isotopes is proposed in terms of two proton holes coupled to a harmonic vibrator. The comparison with experiments on ^{114}Cd is satisfactory. (auth)

30009 (d,p) AND (d,t) REACTIONS ON THE ISOTOPES OF TIN. Schneid, Edward J.; Prakash, Anand; Cohen, Bernard L. (Univ. of Pittsburgh). Phys. Rev., 156: 1316-31(Apr. 20, 1967).

Energy levels up to ~4-MeV excitation energy were studied using the (d,p) and (d,t) reactions. Spectroscopic factors for most of the levels were obtained with the aid of distorted-wave Born-approximation (DWBA) calculations. The $^1/_2{}^+$ state was not identified in ^{123}Sn and ^{125}Sn. Several new l = 2 states were identified as well as several l = 1 and l = 3 states belonging to the 82–126-neutron shell. A renormalization of the DWBA absolute cross sections was performed to eliminate systematic inconsistencies in the sum of $U_j^2 + V_j^2$. The factors of renormalization are found to be within the well-known uncertainties of the DWBA calculations. The values of relative single-particle energies ($\epsilon_i - \epsilon_k$) are calculated both from the occupation numbers (U_j^2 or V_j^2) and from the single-quasiparticle energies (E_j) using pairing theory. The results are in disagreement by as much as 1 MeV or more. From the reactions on the odd isotopes, spin and parity information is obtained for many states in ^{115}Sn, ^{117}Sn, ^{119}Sn, and ^{121}Sn. (auth)

30010 INTERMEDIATES IN THE NUCLEON-TRANSFER PROCESS IN REACTIONS OF ^{14}N WITH ^{133}Cs. Morse, R. I.; Preiss, I. L. (Yale Univ., New Haven). Phys. Rev., 156: 1332-9(Apr. 20, 1967). (YALE-2726-H-85).

The average ranges and excitation functions for ^{132}Cs and ^{130}Cs through ^{127}Cs from the reaction ^{14}N + ^{133}Cs were measured. Angular distributions and differential ranges were also determined for the products ^{132}Cs, ^{130}Cs, ^{129}Cs, and ^{127}Cs. Both the average ranges and angular distributions for ^{130}Cs through ^{127}Cs were found to be the same: at 140-MeV incident energy the angular distributions peak at 34° in the laboratory (full width at half-maximum, 19°) and the recoil energies are 2 MeV. The ^{132}Cs angular distribution and average range correspond to a collision in which a Rutherford trajectory, appropriate to a grazing collision, is followed. The total cross section for ^{130}Cs through ^{127}Cs, at 140 MeV, was found to be 250 ± 35 mb, whereas the cross section for ^{132}Cs is 160 mb. At this energy, upper limits of 0.2 ± 0.2 mb and 30 ± 10 mb were set respectively for the production of ^{131}Cs and ^{128}Cs. A mechanism of nucleon transfer in a peripheral collision followed by deexcitation via nucleon emission from the excited intermediate is considered. Based on this model, angular distributions, average ranges, and excitation functions were calculated and found in good agreement with experimental results. (auth)

30011 14.5-MeV NEUTRON ACTIVATION CROSS SECTION FOR SOME OF THE RARE-EARTH NUCLIDES AND THEIR RELATION TO THE NUCLEAR SHELL STRUCTURE. Menon, M. P.; Cuypers, M. Y. (Texas A and M Univ., College Station). Phys. Rev., 156: 1340-3(Apr. 20, 1967).

The 14.5-MeV neutron cross sections for the production of ^{139m}Ce, ^{140}Pr, ^{141m}Nd, ^{143m}Sm, ^{143g}Sm, and ^{149}Nd nuclides were measured using thick-target samples. The (n,2n) cross sections for the target nuclides, some of which were calculated from previously reported isomeric yield ratios, were plotted as functions of mass number and of the separation energies of the last neutron from the target nuclides. The results are discussed in the light of previously observed neutron shell effects in the systematics of (n,2n) cross sections. The importance of the cross-section measurements to the 14-MeV neutron activation analysis of these rare-earth elements is also pointed out. (auth)

30012 SYSTEMATIC PROPERTIES OF NEUTRON RESONANCES IN THE RARE EARTH REGION. Chrien, R. E.; Mughabghab, S. F.; Bhat, M. R.; Jain, A. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 24B: 573-5(May 29, 1967). (BNL-11327).

The S-wave neutron strength functions, level spacings and potential scattering radius parameters have been measured for a number of nuclides in the rare earth region A = 155 to A = 176. The $\langle\Gamma_n^0\rangle$/D and R′ are compared to rotational optical model calculations. No dependence of strength function on target nucleus spin is found. From a fit of level spacing to the Fermi gas model formula, a spin cut-off factor of 2.8 ± 0.2 is determined. (auth)

30013 INTERACTION OF ^{10}B AND ^{11}B IONS WITH URANIUM NUCLEI. Fleury, A.; Mivielle, F.; Simonoff, G. N. (Faculte des Sciences, Bordeaux). Phys. Lett., 24B: 576-7(May 29, 1967). (In French).

The excitation functions of ^{240}Cm, ^{242}Cm, ^{236}Pu, and ^{238}Pu were studied. Two aspects of the interaction of the B ions were observed: compound-nucleus formation and dissociation of the incident ions. (tr-auth)

30014 DECAY OF THE EXCITED LEVELS OF ^{208}Tl. Benoit, R.; Bertolini, G.; Cappellani, F.; Restelli, G. (CCR-EURATOM, Ispra, Italy). Nuovo Cim. (10), 49B: 125-32(May 11, 1967).

Alpha-gamma and alpha-electron coincidence measurements were performed, using semiconductor detectors, on a source of ^{212}Pb in equilibrium with its daughters. The gamma lines from the excited levels of ^{208}Tl were resolved using a Ge(Li) detector and their relative intensities evaluated. Conversion electrons were measured using Si(Li) detectors. K/L ratios and conversion coefficients for the 288, 328, 451, and 471 keV gamma lines were calculated. (auth)

30015 ANALYSIS OF THE ^{208}Pb(p,t) REACTION. Glendenning, Norman K. (Univ. of California, Berkeley). Phys. Rev., 156: 1344-8(Apr. 20, 1967). (UCRL-17199).

Differential cross sections for the (p,t) reaction leading to many levels in ^{206}Pb were calculated. Three of the transitions are essentially insensitive to the detailed nuclear description, and are used to confirm the treatment of the reaction dynamics. One is therefore in a position to use the reaction to test nuclear wave functions. It is found that agreement between observed and calculated cross sections for many levels is within the assigned errors and confirms the True-Ford wave functions for those levels. (auth)

30016 COLLECTIVE E1 TRANSITIONS IN EVEN-MASS RARE-EARTH NUCLEI. Faessler, A.; Plastino, A. (Univ. of California, Los Angeles). Nuovo Cim. (10), 48B: 429-31(Apr. 11, 1967).

The reduced E1 transition probabilities for even-mass rare-earth nuclei are calculated within the framework of the quasi-particle random-phase approximation. Both the surface delta interaction and the pairing plus octopole force model are used. (S.F.L.)

30017 SYNTHESIS OF ISOTOPES OF ELEMENT 102 WITH MASS NUMBERS 254, 253, AND 252. Mikheev, V. L.; Ilyushchenko, V. I.; Miller, M. B.; Polikanov, S. M.; Flerov, G. N.; Kharitonov, Yu. P. At. Energ. (USSR), 22: 90-7(Feb. 1967). (In Russian).

In tests on the irradiation of ^{242}Pu and ^{239}Pu with ^{16}O and ^{18}O ions, the isotopes ^{254}102, ^{253}102, and ^{252}102 were synthesized. The 254 isotope has a half life of 75 ± 15 sec and E_α = 8.11 ± 0.03 MeV; isotope 253 has a half life of 95 ± 10 sec and E_α = 8.01 ± 0.03; and isotope 252 has a half life of 4.5 ± 1.5 sec and E_α = 8.41 ± 0.03 MeV. The excitation functions in the transition reactions were measured for the identification of the isotopes, and the α decay of the daughter nuclei was recorded. (tr-auth)

30018 NUCLEAR PROPERTIES OF THE ISOTOPES OF ELEMENT 102 WITH MASS NUMBERS 255 AND 256. Druin, V. A.; Akap'ev, G. N.; Demin, A. G.; Lobanov, Yu. V.; Fefilov, B. V.; Flerov, G. N.; Chelnokov, L. P. At. Energ. (USSR), 22: 127-8(Feb. 1967). (In Russian).

The synthesis of the isotopes of element 102 was accomplished by irradiation of natural uranium by ^{22}Ne ions at energies from 117 to 137 MeV in the reactions ^{238}U(^{22}Ne,5n)^{255}102 and ^{238}U(^{22}Ne,4n)^{256}102. The α emitters were identified by determination of the dependence of their yield on the energy of the bombarding ions. The α radiation at 8.41 MeV and the complex α radiation at 8.35 MeV were attributed to isotope 256. The α group at 8.08 MeV with a half life of ~3 min was assigned to isotope 255. (J.S.R.)

30019 MEASUREMENT OF THE REACTOR ABSORPTION CROSS SECTION OF THE ISOTOPES ^{154}Gd AND ^{156}Gd. Grishanin, E. I.; Kukavadze, G. M.; Lependin, V. I.; Memelova, L. Ya.; Morozov, I. G.; Orlov, V. V.; Pilipets, D. T. At. Energ. (USSR), 22: 133-5(Feb. 1967). (In Russian).

The reactor absorption cross sections of ^{154}Gd and ^{156}Gd were measured, and the results of a previous measurement of the reactor cross section of ^{156}Gd measured by a method previously described were carefully analyzed. The results were tabulated for the measurement of the relation of the equilibrium concentrations and the equilibrium concentration and concentration of unspent primary nuclei. They show that the measurements for samples with different isotopic composition agree within experimental error. (J.S.R.)

Nuclear Theory

Refer also to abstracts 27995, 29027, 29352, 29564, 29850, 29893–29895, 29897, 29900, 29910, 29911, 29914, 29915, 29918, 29953, 29964, 29969, 30015, and 30016.

30020 (AED-C-12-15(1)) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 12. OSTLIT-

ERATUR DER KERNWISSENSCHAFTEN. NUMMER 15. KERNPHYSIK. (Bibliographies in Nuclear Science and Technology. Section 12. Nuclear Science Literature of Eastern Countries. Number 15. Nuclear Physics). Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1967. 140p. (In English and German). Dep.

A total of 566 references is given to publications on nuclear physics including general problems, instruments, spectroscopy, detectors, track chambers, nuclear structure studies, and nuclear reactions. (S.F.L.)

30021 (AED-C-12-15(2)) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 12. OSTLITERATUR DER KERNWISSENSCHAFTEN. NUMMER 15. KERNPHYSIK. (Bibliographies in Nuclear Science and Technology. Section 12. Nuclear Science Literature of Eastern Countries. Number 15. Nuclear Physics). Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1967. 170p. (In English and German). Dep.

A total of 626 references is given to publications on nuclear structure, including studies on quantum mechanics of nuclei, Mössbauer effect, and nuclear fission. (S.F.L.)

30022 (AERE-R-5425) MEAN RATE ANALYSIS WITH THE PDP8 COMPUTER. Best, G. C.; Hooton, I. N. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 26p. Dep. CFSTI. UK 3s. 0d.

The technique of mean-rate analysis for multiparameter data is discussed and is shown to be particularly suitable for small computer application. Details of a PDP8 mean-rate analyzer are given with operating instructions and a complete program listing. (auth)

30023 (ANL-7284) PHYSICS DIVISION SUMMARY REPORT, SEPTEMBER-DECEMBER 1966. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 69p. Dep. CFSTI.

The use of (n,γ) and (d,p) reactions in the study of final-state structure was investigated using ^{59}Co and ^{55}Mn as target nuclei. Neutron widths and radiative widths were compared; a correlation was noted. Experimental evidence of multiple-excitation effects in a single-particle-transfer reaction was obtained in a study of the reactions ^{26}Mg(d,t)^{25}Mg and ^{26}Mg(He-3,α)^{25}Mg. A shell-model program in which only the $1d_{\frac{5}{2}}$ and $2s_{\frac{1}{2}}$ single-particle levels are taken into account and in which the residual two-body interaction is characterized in terms of its matrix elements was successfully used to predict the spectra of ^{18}F, ^{19}F, ^{20}F, ^{20}Ne, ^{18}O, ^{19}O, and ^{20}O, as well as the transition rates and static multipole moments of these nuclei. An approximate analytic solution of the three-body problem was also developed. (D.C.W.)

30024 (BNWL-CC-773) PROGRAM GAMMAX. Page, L. J.; Zwibel, H. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 8, 1966. Contract AT(45-1)-1830. 58p. DTIE.

The computer program GAMMAX, which was developed for the calculation of gamma cross sections for pair production and Compton scattering, is described. (D.C.W.)

30025 (INR-778/VII/PL) RECENT DEVELOPMENTS IN THE THEORY OF NUCLEAR MATTER. Dabrowski, Janusz (Institute of Nuclear Research, Warsaw (Poland)). 1967. 30p. (CONF-670117-1). Dep.

From 17th Annual Conference of Nuclear Spectroscopy and Nuclear Structure, Kharkov, USSR.

Since the successful nuclear matter calculation of Brueckner and Gammel in 1958 the situation of the theory for some time became less satisfactory for two reasons. First, calculations with the more up-to-date nuclear forces produced a value of the binding energy per nucleon, $-E/A$, smaller than the empirical value. Second, a careful treatment of the single-particle potential energies of excited states, initiated by Bethe, produced a further reduction in $-E/A$. The second difficulty has been resolved by Bethe, who included into the theory all the three-body diagrams. The series of these diagrams can be summed by an integral equation due to Faddeev. The single-particle potential energies are thereby reduced essentially to zero, and $-E/A$ is increased correspondingly. Thus only the first difficulty remains which, however, can be overcome by applying nuclear forces with a "soft" repulsive core. Recent calculations of $-E/A$ bring its value again into agreement with the experiment. (auth)

30026 (JINR-E4-3286) STATIC QUADRUPOLE MOMENTS OF SPHERICAL EVEN-EVEN NUCLEI. Bal'butsev, E. B.; Dzholos, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 15p. Dep.

The anharmonic corrections to the approximate second quantization method are obtained. The static quadrupole moments of ^{98}Ru, ^{100}Ru, ^{102}Ru, ^{104}Pd, ^{106}Pd, ^{108}Pd, ^{110}Pd, ^{110}Cd, ^{112}Cd, ^{114}Cd, ^{116}Cd, ^{122}Te, ^{124}Te, ^{126}Te, ^{128}Te, and ^{130}Te are calculated. (auth)

30027 (KFKI-5/1967) TABLES FOR FAST IDENTIFICATION OF GAMMA-EMITTERS FROM THE COMBINED HALF-LIFE AND ENERGY DATA. Perneczky, G.; Quittner, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Apr. 5, 1967. 6p. Dep.

Tables are given for the rapid identification of gamma emitters, produced by (n,γ) and fast-neutron reactions, from their approximately known half lives and energies. (auth)

30028 (NASA-TN-D-4000) GENERALIZED POTENTIALS FOR INELASTIC SCATTERING. Volkin, Howard C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 52p. CFSTI.

The generalized potential that gives the scattering into a selected group of inelastic channels along with the elastic scattering is derived by means of the projection operator for the set of channels. A general class of projection operators that selects all open channels is developed in terms of the previous projection operator. The resonance part of the generalized potential can then be obtained by means of Feshbach's unified theory of nuclear reactions. There is no limitation on the types of reactions that can occur. Examples of projectors belonging to the class are given for the case of two-channel reactions. An example which is discussed in some detail is the pickup process. After the resonance contributions have been isolated, the transition amplitudes can be energy averaged. The result is used to obtain the generalized optical potential. The properties of the potentials that follow from the equations which determine them are discussed. A short review is given of some elements of Feshbach's reaction theory that are required. (auth)

30029 (NP-16749) COMPLEX ANGULAR MOMENTUM IN NUCLEAR REACTIONS. Treacy, P. B. (Australian National Univ., Canberra. Research School of Physical Sciences). [1966]. 20p. Dep.

The scattering amplitude and reaction line shapes in a spinless charged-particle channel, are analyzed in terms of poles in angular momentum. The case of ^{4}He + ^{4}He is considered as an example of the one-pole approximation. Practical difficulties are considered in regard to lack of unitarity, wrong threshold behavior and ambiguity of background, in the representation. A modified representation is proposed, from which these difficulties are eliminated. (auth)

30030 (ORO-2791-21) A COMPILATION OF GAMMA RAY ANGULAR DISTRIBUTION COEFFICIENTS. Mathur, S. C.; Buchanan, P. S.; Morgan, I. L. (Texas Nuclear Corp., Austin). Aug. 1966. Contract AT(40-1)-2791. 628p. CFSTI.

A compilation of gamma angular distribution coefficients for nucleon reactions and scattering is presented. The coefficients were calculated for approximately 20,000 spin sequences using the Satchler formalism. (D.C.W.)

30031 (YALE-2726E-49) CALCULATION OF INELASTIC ELECTRON SCATTERING BY NUCLEI. Ziegler, James F. (Yale Univ., New Haven, Conn. Electron Accelerator Lab.). 1967. Contract AT(30-1)-2726. 294p. Dep. CFSTI.

The computer program GBROW, with which electron inelastic scattering can be treated using any phenomenological model of the nucleus or nuclear wave functions, is described. The theoredcal formulation is outlined. (D.C.W.)

30032 (ZfK-PhA-26) EINIGE BEMERKUNGEN ZU AUSWAHLREGELN FUER ELEKTROMAGNETISCHE UEBERGAENGE MIT SPIN-FLIP IN DEFORMIERTEN U-U-KERNEN. (Some Remarks on the Selection Rules for Electromagnetic Transitions With Spin-Flip in Deformed Odd-Odd Nuclei). Bonitz, Manfred; Andreeff, Alexander; Kaestner, Rudolf (Zentralstelle fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Jan. 1967. 15p. (In German). Dep.

It is shown that for spin-flip transitions in deformed odd-odd nuclei two different K-selection rules are possible. In the case in which the direction of the projection of the nuclear momentum on the nuclear symmetry axis is reversed in the transition, $|K_f| + |K_i| \leq L$; otherwise $|K_f - K_i| \leq L$. The first selection rule leads in most practical cases to a high degree of forbiddeness. For instance, the high hindrance factor ($\approx 10^8$) of spin-flip E1 transitions, arising in the decay of the 4.1-μs isomeric state in ^{170}Tm, can be explained after the first rule by thrice K-forbiddeness. If the coupling schemes are well established, it is possible to predict the hindrance of transitions. Very high hindrance of transitions, on the other hand, seems to be related to coupling schemes involving the first selection rule. (auth)

30033 (AD-648883) PROPERTIES OF A FERMI SYSTEM WITH EQUAL SPACINGS BETWEEN ENERGY LEVELS. Yu,

You-wen; Chang, Chung-hwa; Yu, Ming. Translated from Wu Li Hsueh Pao, 19: 483-502(1963). 36p. (FTD-HT-66-495). CFSTI.

A model system containing N fermions, in which each particle possesses three degrees of freedom (angle θ, φ, spin) and the orbital angular momentum of the particles in the degenerated state is l_0, $l_0 - 2$, ..., 0 (l_0 is even) or 1 (l_0 is odd) is proposed. Altogether there are 2 $\Sigma^{l_0}_{0\,(\text{or } 1)}$ (2l + 1) = O particles. Among the particles, there exist interactions of the δ type. Eigen solutions are found for this model system. Characteristics and physical features of the system are discussed. A comparison is also made with the conditions in an atomic nucleus. Results indicate that qualitatively the features of this model system are similar to the equally spaced energy levels in the atomic nucleus. (auth)

30034 THE VALUE OF THE FIERZ TERM AND THE RECENT DATA ON THE ϵ/β^+ RATIO IN FORBIDDEN TRANSITIONS. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 22: 25-7(1967).

From Symposium on Weak Interactions, Lake Balaton, Hungary, May 31–June 5, 1966. See CONF-660565.

In connection with the finite value of the Fierz term derived recently from an ϵ/β^+ ratio measurement, the new data on ϵ/β^+ are analyzed in forbidden transitions. (auth)

30035 BEAM EXTRACTION TECHNIQUES FOR SYNCHROTRONS. Reich, K. H. (CERN, Geneva). pp 161-215 of Progress in Nuclear Techniques and Instrumentation. Vol. 2. Farley, F. J. M. (ed.). New York, John Wiley and Sons, Inc., 1967.

Techniques for obtaining external primary beams from synchrotrons are treated. The advantages of an external primary beam as compared to the internal one are pointed out. Following a discussion of the requirements for bursts of particles, the relevant properties of the internal beam and their control are reviewed. The various extraction techniques are then described, including early ejection schemes for synchrotrons, multiturn ejection, and single turn ejection by magnetic deflection. (L.B.S.)

30036 REMARKS ON THE NEW STRIPPING THEORY OF PEARSON AND COZ. Levin, F. S. (Atomic Energy Research Establishment, Harwell, Eng.). Nuovo Cim. (10), 49B: 199-202 (June 11, 1967).

The theory of deuteron stripping by Pearson and Coz, which makes a number of predictions which relate polarizations and angular distributions from (d,p) reactions and (p,p) elastic scattering, is considered. Although the predictions of this theory are in satisfactory agreement with experiment, it is nevertheless of doubtful validity because it is based on a number of unjustified assumptions. It is indicated how the results of Pearson and Coz, and, in addition, suitable generalizations of these results, may be obtained from the standard DWBA theory by making approximations whose validity can be checked in a full numerical calculation. (J.F.P.)

30037 SYSTEMATICS OF ELECTRIC-DIPOLE TRANSITIONS. Oliva, P.; Prosperi, D. (CNEN, Casaccia, Italy). Nuovo Cim. (10), 49B: 161-84(June 11, 1967).

A systematical analysis of average radiative properties of nuclear levels lying near the nuclear binding energy is presented. Theoretical estimates of electric-dipole radiative widths as well as of elastic-scattering cross sections are presented. All the calculations were carried out by an extrapolation of the E1 giant resonance at lower energies, following a procedure suggested by Axel. A quantitative agreement with experiment was obtained in most cases. It can thus be confirmed that, at least away from closed shells, Axel's extrapolation procedure allows reproduction of the systematical trend of E1 radiative widths below the giant resonance; large shell effects are conversely evident near magic nucleon numbers. (auth)

30038 NONEXISTENCE OF THE TRINEUTRON. Barbi, M. (Univ., Pisa, Italy). Nucl. Phys., A99: 522-8(1967).

Potential depths needed to bind three neutrons in the most likely states are computed by using recently developed techniques of direct numerical solution of the Euler-Lagrange variational equations. The depths obtained are much larger than those compatible with experimental data. (auth)

30039 THE EXACT SOLUTION OF AN N-PARTICLE SYSTEM. Thompson, Kerris W. (Indiana Univ., Bloomington). Nucl. Phys., A99: 421-32(1967).

The solution of an N-particle system in which the particles interact through harmonic two-particle forces is solved exactly under a special restriction on the relative strengths of forces. Methods of solution are given for more general systems, where the restriction is greatly reduced or entirely removed. A special method is introduced to reduce the labor in obtaining solutions of systems with a feature commonly encountered in nature. Some of the possible generalizations are indicated. (auth)

30040 CLUSTER REARRANGEMENT OF THE GROUND-STATE ENERGY EXPANSION FOR NUCLEAR MATTER. Kirson, Michael W. (Univ. of Copenhagen). Nucl. Phys., A99: 353-410 (1967).

The Brueckner-Goldstone expansion for the binding energy of nuclear matter is rearranged as a cluster expansion; and the two-body, three-body and four-body terms are calculated. A careful analysis of the two-body wave-function defect includes all significant correction terms in the reference spectrum approximation and allows a detailed justification of the Bethe-Day method of calculating the three-body terms. It is confirmed that the three-body correlations are dominated by a small range of momenta and that the Bethe and Day reductions of the Bethe-Faddeév equations are quite accurate. Exchange forces and exchange diagrams are explicitly included. The resulting three-body contribution to the energy is small relative to the two-body term. The four-body terms are estimated, and the rapid convergence of the cluster expansion is confirmed, the ratio of successive terms being about 13%. The binding energy at normal density is 18 MeV per particle with a simple nucleon-nucleon interaction. An appendix contains a proof of the generalized factorization theorem (generalized time-ordering procedure) used to put certain reaction matrices on the energy shell. (auth)

30041 ALPHA-CLUSTER PROBABILITY IN NUCLEAR MATTER. Hoersch, K.; Kuemmel, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Phys., 203: 91-116(1967).

An attempt is made to determine the probability of finding a nucleon, in the independent pair model of nuclear matter, as a member of an alpha-particle cluster. Approximate solutions of the Bethe-Goldstone equation furnish analytical expressions for the two-particle correlations of nuclear matter; the potential of Gomes et al. (hard core and attractive square well) is used taking into account the influence of the pair's total momentum. From these functions an approximate four-particle density matrix is constructed. Computation of its overlap integral with the alpha-particle wave function of Mang leads to the alpha-cluster probability as a function of the particle density. For extreme dilution the independent pair model fails. If the results for higher densities, however, are taken to supplement those of Clark and Wang, it is concluded that, in addition to the alpha particles they find in the surface of heavy nuclei, a like number occurs at higher densities, the sharp boundary of their completely clustered surface shell being smeared out. The results on the energy per nucleon of nuclear matter derived from the wave functions are noted. It turns out that properly taking into account the total momentum of each pair amounts to a correction of several MeV. (auth)

30042 INTRINSIC STATES IN ^{58}Ni, ^{42}Ca, ^{30}Si, AND ^{18}O. Bhatt, K. H. (Physical Research Lab., Ahmedabad, India); Parikh, J. C. Nucl. Phys., A98: 113-28(1967).

It is shown that axially symmetric deformed intrinsic states exist for the nuclei ^{58}Ni, ^{42}Ca, ^{30}Si and ^{18}O such that states with definite angular momenta generated from them (using Elliott's procedure) have excellent overlaps with the corresponding states obtained by shell-model calculations. A method of determining the intrinsic state is suggested. It is shown that a determinantal state constructed from single-particle states analogous to the SU_3 states in a Q_0^2 quadrupole field in the absence of the spin-orbit interaction determines the configuration mixing in the intrinsic state with remarkable accuracy. (auth)

30043 COULOMB INTERACTION IN NUCLEI. Gareev, F. A. (Joint Inst. for Nuclear Research, Dubna, USSR); Kalinkin, B. N.; Vagradov, G. M. Nucl. Phys., A98: 136-44(1967).

The effect of correlative forces on the Coulomb interaction between nucleons in the nucleus is considered. It is shown within the framework of the Fermi-liquid theory that the difference in the depth of the proton and neutron average nuclear fields can be explained in terms of those forces. (auth)

30044 SELF-CONSISTENT STRUCTURE OF LIGHT NUCLEI. Irvine, J. M. (Cornell Univ., Ithaca, N. Y.). Nucl. Phys., A98: 161-76(1967).

Nuclear single-particle wave functions are expanded in sets of harmonic oscillator functions. The special properties of these functions allow the derivation of a relatively simple expression for the nuclear reaction matrix elements in the reference spectrum approximation. The same expansion allows a reduction of the Brueckner–Hartree–Fock equations to a set of simple radial equations. The two calculations are coupled together in a straightforward iterative procedure for obtaining self-consistency. The formalism allows a unique definition of a local shell-model potential for light nuclei. The structure of this potential is examined

and some explicit expressions for the nuclei ^{4}He and ^{16}O are presented. (auth)

30045 NOTE ON THE DETERMINATION OF n_{KL} IN ATOMS. Ramaswamy, M. K. (Fordham Univ., New York). Nuovo Cim. (10), 49B: 194-5(June 11, 1967).

A method for determining the number of L-shell vacancies produced in the filling of a K-shell vacancy for the interpretation of x-ray intensity ratios following electron capture and internal conversion and mean L-fluorescence yields is indicated. This method is applicable to nuclei which decay by β emission followed by a single gamma ray such as ^{137}Cs. (J.F.P.)

30046 NOTE ON THE OFF-SHELL SCHATTERING AMPLITUDES. Tanaka, Hiromi (Saga Univ., Japan). Progr. Theoret. Phys. (Kyoto), 37: 469-70(Feb. 1967).

The accuracy of off-shell amplitudes for nucleon-nucleus scattering obtained for incident energies below about 100 MeV assuming a spin-dependent Gaussian potential with the Serber exchange character for the two-nucleon interaction is studied. An investigation is made of how the accuracy of this procedure is influenced by the existence of the hard core in the two-nucleon interaction. It is concluded that while the change of the magnitudes of the off-shell amplitudes by taking account of the hard core is appreciable especially in their imaginary part, it does not cause such a serious effect as to make the use of this procedure invalid for small scattering angles. (J.F.P.)

30047 COULOMB DISTORTION IN HEAVY-ION REACTORS. Beringer, Robert (Yale Univ., New Haven). Phys. Rev. Lett., 18: 1006-7(June 5, 1967). (YALE-2726-H-92).

The classical dynamics of head-on collisions of two liquid-drop nuclei were studied using a Lagrangian formed from the Geilikman interaction potential and the Bohr hydrodynamic collective energies. From the results it is clear that a heavy compound nucleus formed at the barrier has a very large collective energy and in particular, much more energy than is required to fission through a prolate shape. For collisions below the barrier these distortion effects are closely related to Coulomb excitation theory, but the correspondence is not developed. However, it is indicated that strong vibrational excitation is observed in collisions of heavy ions. (J.F.P.)

30048 COMPOUND LEVELS AND THE SHELL MODEL. Yazaki, Koichi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 37: 353-71(Feb. 1967).

A formalism of nuclear reactions is presented which clarifies the meaning of applying the useful shell model calculations to the resonance states as well as the bound states. The main point is the introduction of the internal region in the wave function space. An effective Hamiltonian is defined in this subspace, the diagonalization of which gives the energies and the wavefunctions for the resonance states as well as the bound states. As an application of the theory, calculations of the level widths are carried out for ^{5}He nucleus. (auth)

30049 ON APPLICABILITY OF THE RANDOM PHASE APPROXIMATION TO THE COLLECTIVE EXCITATION IN SPHERICAL EVEN NUCLEI. I. CORRECTION TO THE FIRST 2^{+} STATES IN SINGLE CLOSED SHELL NUCLEI. Tokunaga, Akira (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 37: 315-35(Feb. 1967).

In order to check the applicability of the random phase approximation (RPA), the correction to the RPA for the first 2^{+} state in spherical even nuclei is evaluated using a kind of perturbation theory (starting with the solutions of the RPA as zeroth-order approximation). According to the method, in so far as the first-order correction is concerned, some ambiguities depending on various methods to transcribe the system into the boson space are avoidable. Physical implication of the correction is considered. Numerical results for Ni-isotopes (^{60}Ni and ^{62}Ni) and for the single j = $1\frac{5}{2}$ shell model show that the correction to the RPA is unexpectedly large in the region of "phonon" energy which is of interest. One is thus forced to conclude that the conventional approach in terms of the RPA should be modified since in nuclear problems the total number of states in the shell under consideration, Ω, is not so large to guarantee the RPA and, as a result, the magnitude of correction in that region becomes highly sensitive to the force-strength α. (auth)

30050 ON APPLICABILITY OF THE RANDOM PHASE APPROXIMATION TO THE COLLECTIVE EXCITATION IN SPHERICAL EVEN NUCLEI. II. CORRECTION TO THE SO-CALLED TWO-PHONON STATES IN SINGLE CLOSED SHELL NUCLEI. Yamamura, Masatoshi; Tokunaga, Akira; Marumori, Toshio (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 37: 336-52(Feb. 1967).

The concept of the "2-phonon" states is checked through an analysis of the characteristic features of the first order correction to the conventional "2-phonon" states under the RPA. Numerical results for Ni-isotopes (^{60}Ni and ^{62}Ni) and for the single j = $1\frac{5}{2}$ shell model show that the concept of the "2-phonon" states based on the RPA is in breakdown, in the sense that the correction is unexpectedly large in the region of the phonon energy of interest. There is also another important physical situation to destroy the concept of the "2-phonon" from the fact that coupling between the "2-phonon" modes and other 2-quasi-particle excitation modes is essential in most actual nuclei. (auth)

30051 STRONG INTERACTION CORRECTIONS TO COULOMB-COHERENT PRODUCTION OF ρ BY π ON NUCLEI. Leroy, J. P. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 49A: 213-23(May 21, 1967).

The one-pion exchange contribution to ρ production by π on nuclei is computed by means of a modified pion propagator through nuclear matter and compared to the Coulomb production. (auth)

30052 K-ELECTRON EJECTION ACCOMPANYING NUCLEAR K CAPTURE. Intemann, R. L. (Temple Univ., Philadelphia); Pollock, F. Phys. Rev., 157: 41-50(May 5, 1967).

The momentum spectrum for the K electrons ejected during allowed K capture is calculated in the lowest order of perturbation theory using a nonrelativistic approximation for the electrons. The differences between this theory and the previously developed theory of Primakoff and Porter are pointed out. The new theory yields a spectrum which is virtually identical to the Primakoff-Porter spectrum over almost the entire momentum range of the ejected electrons. A discussion of relativistic effects and effects due to atomic screening and nuclear recoil is given. The discrepancies existing between the theoretical predictions and the experimental results are also discussed. (auth)

30053 COLLECTIVE EXCITATIONS IN NUCLEI. Belyaev, S. T. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 213-88 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

The phenomenological and microscopic approaches to the description of collective excitations in nuclei are presented. Vibrational and rotation excitations and pairing correlations are first treated. The various approximate methods are then discussed: self-consistent field; time-independent self-consistent field; and time-dependent self-consistent field (perturbation-theory and adiabatic approaches). (L.B.S.)

30054 RECENT EXPERIMENTAL TESTS OF NUCLEAR MODELS. Bayman, B. F. (Univ. of Minnesota, Minneapolis). pp 441-589 of Many-Body Problems and Other Selected Topics in Theoretical Physics. Moshinsky, M.; Brody, T. A.; Jacob, G. (eds.). New York, Gordon and Breach Science Publishers, 1966.

A brief review is given of the theory of angular momentum. Angular momentum operators as generators of rotations, the Wigner D matrices, spherical harmonics, vector coupling coefficients and the Wigner-Eckart theorem, spinor wave functions, and motion of a particle in a central field are discussed under this section. Section II treats the spherical shell model. The isobaric-spin quantum numbers and their usefulness in classifying the eignefunctions of a charge-independent Hamiltonian are discussed in section III. Section IV reviews the distorted wave Born approximation as it is currently applied to direct reactions, focussing attention on the way nuclear structure information is extracted from the experimentally observed differential cross section. (L.B.S.)

30055 SURFACE DELTA INTERACTION IN DEFORMED NUCLEI. Faessler, Amand; Plastino, A.; Moszkowski, S. A. (Univ. of California, Los Angeles). Phys. Rev., 156: 1064-71(Apr. 20, 1967).

The surface delta interaction (SDI) is applied to deformed nuclei. It is shown that the relations among the matrix elements of the SDI derived for spherical nuclei are also valid in the deformed case. The parameter of the SDI can be fixed by the odd–even mass differences or it can be calculated utilizing a self-consistency argument for the density and the shape of the potential. Comparing the matrix elements for the pairing-plus-quadrupole (or octupole) force with the elements for the SDI, one can calculate the strength of the quadrupole and octupole forces from nuclear binding energies. The values so derived are in good agreement with the fits found in the literature for the quadrupole and the octupole parameters. (auth)

30056 DOUBLE-SCATTERING CORRECTIONS TO MEDIUM- AND HIGH-ENERGY INELASTIC NUCLEON SCATTERING. Nguyen Van Giai (CNRS, Orsay, France); Sawicki, J. Phys. Rev., 156: 1077-87(Apr. 20, 1967).

Double-scattering corrections to the differential cross section

for the inelastic scattering of nucleons from complex nuclei are calculated. The Watson formalism of multiple scattering is employed. Numerical computations are performed for the reaction $^{12}C(p,p')^{12}C^*$ (2^+ state, 4.43 MeV) for the incident proton energies E_0 = 156, 100, and 90 MeV. The 2^+-state eigenvector is taken from a microscopic random-phase-approximation model calculation. The computed double-scattering corrections to $\sigma(\theta)$ are appreciable and negative at small θ (at 156 MeV of the order of $-10 \sim -20\%$). They are rather sensitive to the details of the final-state nuclear wave function. (auth)

30057 ATTEMPT TO FIX THE NUCLEON–NUCLEON PARAMETERS BY EXAMINING NUCLEON–NUCLEUS SCATTERING. Chalmers, Joseph S.; Saperstein, Alvin M. (Wayne State Univ., Detroit). Phys. Rev., 156: 1099-1110(Apr. 20, 1967).

The scattering of protons and neutrons from carbon at 142, 210, and 310 MeV is calculated using an optical potential obtained from nucleon–nucleon scattering amplitudes with the impulse, single-scattering, and energy-shell approximations. The integral scattering equation in momentum space is solved numerically using this potential. The present calculation is compared to previous approximate solutions and to the data. An attempt is made to choose among the currently available nucleon–nucleon phase-shift sets. (auth)

30058 OPTICAL POTENTIAL CORRELATION CORRECTION FROM DEUTERON–NUCLEUS SCATTERING. Reading, J. F. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 156: 1110-15(Apr. 20, 1967).

To describe deuteron–nucleus scattering accurately at high energies, one has to correct the approximation that the potential which acts on the deuteron is the sum of the neutron and proton optical potentials. This correction is largely due to nuclear correlations and presents a method of determining the correction to the nucleon optical potential due to correlations. The method is applied to 650-MeV deuteron–Carbon scattering. Good agreement is found between theory and experiment. (auth)

30059 A SCHEMATIC HAMILTONIAN INCLUDING A CONTINUOUS SPECTRUM FOR PARTICLE-HOLE EXCITATIONS. Agodi, A.; Catara, F.; Di Toro, M.; Stazi, O. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Nuovo Cim. (10), 48B: 237-48(Apr. 11, 1967).

In the space spanned by all particle-hole states, the coupling between those of the usual truncated set and the others is investigated as the effect of a factorable residual interaction. The point spectrum and the electromagnetic transition probabilities for transitions connecting its eigenstates to the ground state are determined and the results are compared with those of the schematic TD model. One finds that the coupling between discrete and continuum particle-hole states has effects on the discrete spectrum and, in the T = 0 case, on the electromagnetic transition probabilities similar to those of including particle correlations in the ground state as evaluated in the random-phase approximation. (auth)

30060 EFFECT OF PAIRING CORRELATIONS ON MAGNETIC-OCTUPOLE MOMENTS. Freed, N. (Pennsylvania State Univ., University Park). Nuovo Cim. (10), 48B: 437-42 (Apr. 11, 1967).

The existing data on magnetic octupole moments is accurately explained by considering the effects of pairing correlations and higher-seniority contributions admixed by a delta force. The calculations suggest that octupole moments are as sensitive to details of spherical wave functions as are dipole moments. (S.F.L.)

30061 TOWARD A NEW THEORY OF SPHERICAL NUCLEI. II. Dreizler, R. M. (Univ. of Pennsylvania, Philadelphia); Klein, A.; Wu, Chi-shiang; Do Dang, G. Phys. Rev., 156: 1167-72(Apr. 20, 1967). (NYO-2171-215).

A study is carried out of one of several possible mechanisms contributing to the quadrupole moment of the first excited (2^+) state of spherical nuclei. The possibility of a deformed solution is investigated for a set of Hartree–Bogoliubov equations describing the 2^+ state in an angular-momentum-conserving approximation. In the pairing-plus-quadrupole–quadrupole model, a sharp transition from spherical to deformed density distribution is shown to occur just beyond the value of the quadrupole coupling strength necessary to yield the 2^+ excitation energy. (auth)

30062 TOWARD A NEW THEORY OF SPHERICAL NUCLEI. I. Do Dang, G. (Faculte des Sciences, Orsay, France); Klein, A. Phys. Rev., 156: 1159-66(Apr. 20, 1967). (NYO-2171-214).

A tentative theory of the quadrupole moment Q_2^+ of the first 2^+ excited state of spherical nuclei is developed as a logical extension of the methods used in the usual theory based on pairing plus quadrupole–quadrupole interaction. In the latter, in which the quasi-particle occupation amplitudes in the ground state are taken to be of zero order and the off-diagonal amplitudes connecting the ground state with the 2^+ state to be of first order (and described by the random-phase approximation), Q_2^+ is nominally of second order. It is found that, in a consistent calculation, the quadrupole deformation is driven by the off-diagonal amplitudes, but that there is also the possibility of a self-sustained deformation for sufficiently large quadrupole coupling constants. Numerically, one finds ranges of the latter, all in accord with the excitation energy and the E2 transition probability, for which Q_2^+ shows extremely rapid variations, and in particular, also assumes values sufficiently large to contradict the whole basis of the calculation. The need for a self-consistent intermediate coupling calculation is indicated. (auth)

30063 HIGH-ENERGY APPROXIMATION AND THE NON-LOCAL NUCLEON–NUCLEUS WATSON POTENTIAL. Reading, J. F. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 156: 1116-19(Apr. 20, 1967). (MIT-2098-266).

The high-energy approximation is used to evaluate an effective local optical potential to describe nucleon–nucleus scattering in terms of soft-core two-body potentials. (auth)

30064 KINEMATIC CORRELATIONS IN NUCLEON–NUCLEUS SCATTERING. Reading, J. F. (Oxford Univ.). Phys. Rev., 156: 1120(Apr. 20, 1967).

A kinematic effect which occurs in nucleon–nucleus scattering and which is treated differently in various approximations is discussed. (auth)

30065 RELATIVE-ANGULAR-MOMENTUM-ZERO PART OF TWO-NUCLEON WAVE FUNCTIONS. Bayman, B. F.; Kallio, A. (Univ. of Minnesota, Minneapolis). Phys. Rev., 156: 1121-8(Apr. 20, 1967).

A method is given for finding the relative-angular-momentum-zero part of the wave function of two particles moving in a finite single-particle potential. The results are applied to form factors for two-nucleon transfer reactions and to two-nucleon interaction matrix elements. (auth)

30066 COULOMB FORCES IN QUANTUM-MECHANICAL THREE-BODY PROBLEMS. Schulman, Lawrence (Princeton Univ., N. J.). Phys. Rev., 156: 1129-32(Apr. 20, 1967). (UCRL-70215).

A method for handling the three-body problem with two of the particles charged is presented in terms of the corresponding uncharged problem. Coulomb wave functions are used in the relative coordinate of the charged particles, and the resulting expressions are subjected to an approximation. The technique should be useful for ^{3}He calculations. (auth)

30067 SHELL-MODEL SPIN-ORBIT FORCE RADIUS ANOMALY. Sprung, Donald W. L; Bhargava, P. C. (McMaster Univ., Hamilton, Ont.). Phys. Rev., 156: 1185-7(Apr. 20, 1967).

It has recently been shown that the spin-orbit part of the optical-model potential, taken to be a surface-gradient force, is displaced about 0.1A$^{1/3}$F inside the central well. For the shell-model potential this feature arises very naturally from the Brueckner many-body theory, the spin-orbit force being strongly density-dependent while the central force saturates at nuclear densities. (auth)

30068 LINEARIZATION OF THE PAIRING HAMILTONIAN. Chasman, R. R. (Argonne National Lab., Ill. Royal Inst. of Tech., Stockholm. Research Inst. for Atomic Physics, Stockholm). Phys. Rev., 156: 1197-1200(Apr. 20, 1967).

The pairing-Hamiltonian eigenstates are used to test linearization procedures for the equations of motion of pair-creation operators. It is found that standard linearization techniques are inadequate and additional terms are suggested by a detailed examination of pairing wave functions. The new linearization procedure is applied with considerable success to the pairing vibration problem. Possible extension of the results to more general two-body interactions is discussed. (auth)

30069 THE 1-FORBIDDEN MAGNETIC DIPOLE TRANSITIONS. Shikata, Y. (Tokyo Univ.). Phys. Lett., 24B: 557-9 (May 29, 1967).

It is shown by first-order perturbation calculation that the tensor force is important to explain observed data of the 1-forbidden M1 transitions. (auth)

30070 MULTIPOLAR SUM RULES FOR ELECTROMAGNETIC INTERACTIONS WITH NUCLEI. Quarati, P. (Univ., Cagliari, Italy). Nuovo Cim. (10), 49B: 32-40(May 11, 1967).

The sum rules for all the multipoles of electro-magnetic interactions of real and virtual photons with nuclei are deduced. (auth)

30071 ANGULAR CORRELATIONS IN PICK-UP AND KNOCK-OUT NUCLEAR REACTIONS. Beloshitsky, V. V. (Moscow State Univ.). Phys. Lett., 24B: 559-62(May 29, 1967).

The application of the angular correlations method to studies of the relation of different direct nuclear reaction mechanisms is proposed. As an example the $^{14}N(^3He,\alpha)^{13}N$ reaction is considered. The angular correlations of α-particles with the decay protons were calculated in the plane-wave Born approximation under the assumption that the reaction proceeds by the knock-out or pick-up at the nuclear surface. The correlation function is shown to be different for knock-out and pick-up even when the angular distribution is practically the same for both mechanisms. (auth)

30072 ALPHA–DEUTERON MODEL AND THE FORM FACTOR OF ^{6}Li. Ali, S.; Afzal, S. A. (Atomic Energy Centre, Dacca, Pakistan). Nuovo Cim. (10), 49B: 103-15(May 11, 1967).

An α-d model of ^{6}Li was studied in which allowance was made for a distortion of the deuteron wave function by the α-particle by minimizing the total energy (i.e., the relative α-d energy plus the internal energy of the deuteron) with respect to the parameters of a suitable trial function for the deuteron. The results indicate that such distortions of the deuteron in ^{6}Li are probably not very appreciable and lead to a small increase in the binding energy of the ground state. The form factor of ^{6}Li was calculated with this model and was found to be fairly satisfactory within the limitations of the approach. The adequacy of the model is also discussed. (auth)

30073 MUON CAPTURE IN ^{16}O AND ^{40}Ca. Foldy, L. L.; Klein, R. H. (Case Inst. of Tech., Cleveland. Western Reserve Univ., Cleveland). Phys. Lett., 24B: 540-2(May 29, 1967).

Bunatyan's theory of muon capture in ^{16}O and ^{40}Ca is compared with the theory of Foldy and Walecka and is shown to differ substantially in content in spite of some superficial similarities in intent. Determination of the mean nuclear excitation energy following capture would serve to distinguish between the two theories experimentally. (auth)

30074 HYPERTRITON WITH SEPARABLE NONLOCAL INTERACTION WITH HARD SHELL REPULSION. Borysowicz, J.; Dabrowski, J. (Univ. of Warsaw). Phys. Lett., 24B: 549-51(May 29, 1967).

The $^3_\Lambda$H problem is solved exactly with separable nonlocal nucleon–nucleon and Λ-nucleon potentials with a hard shell radius $r_c = 0.4$ fm. For three sets of Λ-nucleon scattering parameters, the binding energy and the probability of the S′ state are calculated. (auth)

30075 COULOMB FISSION BY VERY HEAVY IONS. Wilets, L. (Univ. of Washington, Seattle); Guth, E.; Tenn, J. S. Phys. Rev., 156: 1349-58(Apr. 20, 1967).

It is proposed that very heavy ions (including uranium) be utilized to induce fission through the Coulomb interaction only. Because the projectile moves slowly, the process is expected to be nearly adiabatic (no intrinsic excitation). Dynamical-model calculations were performed at zero impact parameter to determine the threshold energy, cross section, and fragment angular distribution. Differential cross sections of hundreds of millibarns are calculated, and fission fragments are found to emerge preferentially at 90° in the pair frame. The calculations incorporate reasonable model data, but the equilibrium-to-saddle distance $\Delta\beta$ is unknown. In order for fission to occur below the Coulomb barrier, $\Delta\beta$ must be greater than 0.15 in the case of Cf, for example. Rotational and vibrational excitation is discussed for energies below the fission threshold. A primary objective of the experiments would be to determine $\Delta\beta$ (and the shape of the energy-deformation curve). This would provide a severe test of various nuclear-model theories. (auth)

30076 CALCULATIONS OF ALPHA-PARTICLE TRAJECTORIES IN LONG-RANGE ALPHA PARTICLES EMITTED IN SPONTANEOUS FISSION. Boneh, Y. (Nuclear Research Center, Negev, Israel); Fraenkel, Z.; Nebenzahl, I. Phys. Rev., 156: 1305-16(Apr. 20, 1967).

Calculated angular and energy distributions of the α particles in long-range α-particle fission are presented. The distributions were obtained from calculated α-particle trajectories based on a three-point-charge model for the scissioning nucleus. The calculation is two dimensional, and spontaneous fission (no preferred direction) is assumed. This reduces the number of free variables of the system to seven (except for the mass ratio). The system is thus parametrized in terms of the following initial dynamical variables: the initial distance between the fission fragments, the initial position of the α particle (not restricted to the fission axis), and the initial momenta of the α particle and one of the fragments. Reasonably good agreement with the experimental distributions is obtained. The calculations support the view that the scission point moves closer to the light fragment as the mass ratio increases. They also support the assumption that at the moment of scission the fission fragments have already attained a substantial part of their final velocity. (auth)

30077 TWO-NUCLEON HARD-CORE INTERACTION IN A COMMON HARMONIC-OSCILLATOR POTENTIAL. Niblack, W. K. (State Univ. of New York, Bufalo); Nigam, B. P. Phys. Rev., 156: 1191-6(Apr. 20, 1967).

The problem of two nucleons with no interaction except a repulsive hard core, assuming that both move in a common harmonic-oscillator potential, is considered. Analytic forms are obtained for the wave functions and the energy eigenvalues which are found to depend on the radius of the hard core. The method is applied to the calculation of the spin-orbit splitting in ^{17}O, treating the two-nucleon spin-orbit interaction as a perturbation and using the hard-core wave functions as the unperturbed wave functions. A value of 5.95 MeV is obtained for the spin-orbit separation for the $J = \frac{1}{2}$ and $J = \frac{3}{2}$ levels of ^{17}O. (auth)

30078 SHELL-MODEL CALCULATIONS WITH SEPARABLE POTENTIALS. Hodgson, R. J. W. (Univ. of Sydney). Phys. Rev., 156: 1173-84(Apr. 20, 1967).

Shell-model calculations are performed on ^{18}O, ^{42}Ca, ^{90}Zr, ^{210}Po, and ^{18}F using separable potential forms. In most cases, the potentials have been fitted to low- and intermediate-energy two-body data. The over-all agreement is quite good, and the calculations are considerably simpler than similar ones using hard-core potentials. Replacing the potential matrix by an approximate reaction matrix offers no general improvement and produces results which are comparatively insensitive to the potential parameters. (auth)

30079 CONSTRUCTION AND OPERATION OF THE ARGONNE PION FOCUSING HORN. Vogel, H. F. (Argonne National Lab., Ill.); Yovanovitch, D. D.; Novey, T. B.; Lundy, R. A.; Lamb, R. C.; Telegdi, V. L.; Winston, R. pp 501-4 of V International Conference on High Energy Accelerators. Rome, Comitato Nazionale per l'Energia Nucleare, 1966.

The construction and operation of the Argonne meson (π) focusing horn which is used for focusing mesons (π) from a beryllium target bombarded with protons from the ZGS and as a source for producing neutrinos are discussed. (B.G.D.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 28042, 28332, 29824, 29828, 29839, and 29851.

30080 (AAEC/E–166) EQUIVALENCE RELATIONS FOR HETEROGENEOUS REACTOR SYSTEMS. Keane, A.; McKay, M. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1966. 12p. Dep.

A derivation is given of an equivalence relation between heterogeneous and homogeneous systems, which allows for close-packing without the need for a Dancoff correction and which includes fuels dispersed in granular form. An alternative derivation of the equivalence relation is also presented, giving insight into the physical significance of the rational approximation. (auth)

30081 (ACNP–67514) PATHFINDER ATOMIC POWER PLANT RESPONSE TO SCRAM AND RUNBACK TESTS (431). Shultz, T. G.; Stone, J. T. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Apr. 1967. Contract AT(11-1)-589. 42p. Dep. CFSTI.

During power escalation of the Pathfinder Atomic Power Plant, a test program was conducted to evaluate response of the power plant to safety actions. The safety actions involved were: reactor scram, control rod runback, turbine trip, and turbine load dump. The final report on this phase of the testing program is presented. Descriptions of expected plant response to each safety action are included. Individual tests are discussed in detail. Reproductions of the recorded results of each test are included. An unusual occurrence which was consistently observed throughout the testing program is detailed; this occurrence consisted of an oscillation in steam line pressure following isolation scram, turbine trip, and turbine load dump. The source, characteristics, and effects of the oscillation are discussed. (auth)

30082 (AE–271) IMPROVEMENT OF REACTOR FUEL ELEMENT HEAT TRANSFER BY SURFACE ROUGHNESS. Kjellstroem, B.; Larsson, A. E. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1967. 98p. Dep.

In heat exchangers with a limited surface temperature such as reactor fuel elements, rough heat transfer surfaces may give lower pumping power than smooth. To obtain data for choice of the most advantageous roughness for the superheater elements in the Marviken reactor, measurements were made of heat transfer and pressure drop in an annular channel with a smooth or rough test rod in a smooth adiabatic shroud. 24 different roughness geometries were tested. The results were transformed to rod cluster geometry by the method of W. B. Hall, and correlated by the friction and heat transfer similarity laws as suggested by D. F. Dipprey and R. H. Sabersky with rms errors of 12.5% in the friction factor and 8.1% in the Stanton number. The relation between the Stanton number and the friction factor could be described by a relation of the type suggested by W. Nunner, with a mean error of 3.1% and an rms error of 11.6%. Application of the results to fuel element calculations is discussed, and the great gains in economy which can be obtained with rough surfaces are demonstrated by two examples. (auth)

30083 (AECL–2875) REVIEW OF 1965 FORECAST OF INSTALLED NUCLEAR CAPACITY (1970–1985). Merlin, H. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 30p. (CONF-670522–6). Dep. CFSTI. CAN $1.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

The forecast of installed nuclear capacity prepared by the Economic Planning Committee of the Canadian Nuclear Association in 1965 is compared with other global forecasts published in 1966. In view of the number of orders for nuclear plants in the past two years in the United States, the forecast of installed nuclear capacity prepared in 1965 may be conservative. By 1985 the installed nuclear capacity may be 430,000 MW in countries outside the communist bloc or 35% greater than the original prediction. Uncertainties, however, limit the accuracy of the forecast to about 20%. (auth)

30084 (AECL–2876) DRYOUT IN BOILING WATER REACTORS. McPherson, G. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 12p. (CONF-670522–5). Dep. CFSTI. CAN $0.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

The development of fuel assemblies to operate at high coolant quality should improve the economics of Canadian boiling water reactors. Present practice is to operate at conditions at which the sheath is completely wetted. The combination of design parameters at which dry sheath operation (dryout) would begin represents an important boundary to the reactor designer. Experimental studies have revealed what factors affect dryout and many attempts have been made to relate these factors. (auth)

30085 (AECL–2886) EVOLUTION OF NUCLEAR POWER IN CANADA. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 12p. (CONF-670522–8). Dep. CFSTI. CAN $0.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

Canada has been involved in nuclear research and development since the 1940's. Much of the effort has been devoted to the economic production of electricity; two power stations are in operation and larger ones are now being built. Economic considerations favor rapid expansion of nuclear power to satisfy Canadian needs and export markets; costs will probably fall below 2.5 mills/kwh. The environment provides strong incentives to hold down capital costs and to introduce automation for operating routines. Vigorous research and development is needed, especially on materials. (auth)

30086 (AED-C–01-14) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. BAUWESEN. (Bibliographies in Nuclear Science and Technology. Civil Engineering). Mueller, C. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Feb. 1967. 103p. (In German). Dep.

The titles of 131 articles published up through 1966 on the use of prestressed concrete in the construction of reactor pressure vessels are compiled. Availability of all articles is listed. Abstracts are given for some of the papers. Both author and journal indexes are also provided. (M.L.S.)

30087 (AEEW-R–397) THE VALIDITY OF METHUSELAH II IN WATER MODERATED LATTICE CALCULATIONS. Hicks, D.; Hopkins, D. R. (Atomic Energy Establishment, Winfrith (England)). Sept. 1964. 36p. Dep. CFSTI. UK 5s.

An improved version of the METHUSELAH code has been developed, which embodies some refinements in the treatment of the thermal spectrum, improved cross-section data, and a neutron balance output. The changes in nuclear data and physical models are summarised; a detailed description of the programme modifications will be published separately. METHUSELAH II predictions are compared with published lattice reactivity and reaction rate data. The systems examined include British S. G. H. W. type lattices (with H_2O and D_2O moderation), Canadian natural U/D_2O experiments, U. S. low enrichment H_2O systems, and the Hanford Pu Al/H_2O experiments. In general the agreement is sufficiently good to demonstrate the value of METHUSELAH II as an assessment tool, and to indicate clear improvements over METHUSELAH I. A number of discrepancies are observed, however, and are the subject of comment. (auth)

30088 (AEEW-R–728) TEMPLE: A COMPUTER PROGRAM FOR TRANSFORMING REACTOR TRANSFER FUNCTIONS FROM THE FREQUENCY DOMAIN TO THE TIME DOMAIN, AND VICE VERSA. Matthews, J. D. (Atomic Energy Establishment, Winfrith (England)). Mar. 1967. 16p. Dep.

A computer program TEMPLE is described; it integrates, numerically, the Laplace equations in order to convert transfer functions from the frequency to time domain (and vice versa). While specifically designed for fast reactor functions, it has applications in many other fields, including heat transfer and electric circuit theory. (auth)

30089 (AI–66–53) EFFECTS OF LONG-TERM SODIUM EXPOSURE ON MATERIALS IN THE SODIUM REACTOR EXPERIMENT. Mannas, D. A. (Atomics International, Canoga Park, Calif.). June 15, 1966. 74p.

Recent modification of the Sodium Reactor Experiment (SRE), to permit operation at higher temperature and power levels, provided an opportunity to determine the effect of long-term exposure to Na on materials in a large Na-heat-transfer system. The entire primary system and much of the secondary system were removed for the modification. All items removed from the system were examined visually, with emphasis placed on the detection of wear, erosion, and deposits. Carbonaceous deposits were expected from the decomposition of organic pump coolant (Tetralin), which was known to have leaked into both the primary and secondary systems. Particular attention was thus directed to gather evidence of carburization of any of the components. No evidence of corro-

sion, erosion, or cracking was found in the primary or secondary Na systems. Several types of deposits and reaction layers were observed in various parts of the system, but no evidence of an impending functional failure was detected. It was concluded that large Na systems, similarly operated, can be expected to have a life commensurate with normal power plant practices and requirements. (auth)

30090 (ANL-7007) PHYSICS MEASUREMENTS IN TUNGSTEN-BASED, ALUMINUM-REFLECTED FAST REACTORS. Doerner, R. C.; Knapp, W. G.; Almenas, K. K.; Karam, R. A. (Argonne National Lab., Ill.). Mar. 1967. Contract W-31-109-eng-38. 38p. Dep. CFSTI.

The results of measurements made on four fast critical experiments performed in ZPR-9 summarized in support of the rocket-design effort. The fuel is highly enriched ^{235}U, the major diluent is a W-Re alloy, and the reflector material is Al. Data on cross section sets for W, Re, and ^{10}B are included. (J.C.W.)

30091 (ANL-7210) REACTOR PHYSICS DIVISION ANNUAL REPORT, JULY 1, 1965 TO JUNE 30, 1966. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 446p. Dep. CFSTI.

Brief descriptions of work on the following subjects are presented: fission properties and cross section data including fast neutron scattering studies, elastic neutron scattering from elements of intermediate weight, elastic neutron scattering from Mg and Si, fast neutron scattering from nuclei in the mass region A = 95-130, the interaction of fast neutrons with the 182, 184, and 186 isotopes of W, a search for fluctuations in the fission cross section of ^{235}U, neutron flux measurements in the 10-200 keV region, (d,n) stripping reactions, fast neutron total cross sections using a monoenergetic source and an automatic facility, fast neutron energy degradation through the (n,γn′) process, unitary models of nuclear resonance reactions, the ^{252}Cf fission neutron spectrum from 0.003-15.0 MeV, direct and absolute measurements of average yield of neutrons in the thermal fission of ^{235}U and spontaneous fission of ^{252}Cf, spontaneous fission half-lives of ^{242}Cm and ^{244}O Cm; thermal reactor physics including High Conversion (Hi-C) critical experiment, Hi-C uniform lattice calculations, initial critical experiments of the EBWR Pu recycle program, measurement of capture-to-fission ratios of ^{239}Pu and ^{241}Pu in the Pu loading of the EBWR, control rod evaluation for thermal and intermediate reactors, small reactivity measurements in the Argonne Thermal Source Reactor (ASTR), neutron beam spectra extracted from the High Flux Irradiation Reactor, Argonne Advanced Research Reactor (AARR) critical experiments-preface, AARR critical experiments-control blade worths, AARR critical experiments-prompt neutron lifetime measurements by the Rossi-alpha technique, AARR critical experiments-Cd ratio measurements, AARR critical experiments-activation and power distribution measurements, AARR critical experiments-void and material reactivity worths and temperature coefficients, AARR critical experiments-beam tube experiments, AARR critical experiments-startup source requirements and instrument response, AARR calculations-preface, AARR calculations-analysis of the critical experiments, AARR calculations-general reactor physics design analysis, AARR calculations-reactor physics characteristics of the ITC, AARR calculations-factors in optimization of experimental fluxes, AARR calculations-shield design analysis, AARR calculations-analyses of hypothetical accidents; fast reactor physics including the neutron energy spectrum in a dilute UC-fueled fast critical assembly, neutron spectra in depleted U, calculations of Na-void coefficients in large fast neutron carbide cores in assemblies No. 2 and 3 of ZPR-6, calculations of the effect of thin slab heterogeneities on the non-leakage reactivity component of Na voiding, non-linearity in the spectral component of Na void effect as a function of Na content, effect of parameter uncertainties on Na void effect and critical size of fast reactors, Doppler-effect measurements on a dilute carbide fast assembly-ZPR-6 assembly No. 4Z, measured physics parameters in a zoned fast UC core-ZPR-IV assembly No. 42, analysis of the uncertainties in the interpretation of zone loaded experiments, measurement of the spatial distribution of the importance of fission neutrons in ZPR-6 assembly No. 4Z, standard deviation of ion chamber current measurements in ZPR-6 assembly 4Z, measured reactivity removal rates in ZPR-6 assembly No. 4Z, the Argonne National Laboratory of ZPR-3 assembly No. 48, critical assembly comparison calculations using new cross section data, comparative neutronic characteristics of metal, oxide and carbide EBR-II driver fuels, the effect of fuel and blanket changes on the EBR-II flux, FARET Core I fuel irradiation program and reference design, twenty-six group cross section set for W-based rocket systems, physics measurements in fast W rocket reactor critical experiments, measurement of space-dependent material worths in several ZPR-9 assemblies, rocket critical assemblies analysis, physics measurements in an operating fast breeder power reactor, further neutronic studies of the 1000 MW(e) metal-fueled fast breeder reactor, reactor physics calculations for a 10,000 MW(th) fast Na-cooled breeder, fast breeder reactors for water desalting, criteria for the density of monitoring points in large reactors; fast reactor safety including capabilities of the present TREAT facility core as a fast flux loop meltdown facility, meltdown experiments using the Mark I integral Na loop, analyses of single pin loop meltdown experiments, properties of irradiated UO_2 pins prior to TREAT facility transients, photographic fast reactor safety experiments on irradiated oxide pins at the TREAT facility, transient in-pile tests on UO_2-W cermet rocket fuel samples, design of the Mark II integral TREAT facility Na loop, calibration mockup for the large loop test section for the TREAT facility, transient response of stand-off pressure transducer assemblies on the TREAT facility integral Na loops, extensible multi-purpose vacuum glove box, experimental results and improvements in the fast neutron hodoscope, the exact three-dimensional solution for thermoelastic stresses and displacements in finite and infinite tubes, transient vaporization of Na in reactor coolant channels, convective heat or mass transfer with phase changes, theoretical prediction of thermodynamic and transport properties of metal vapors, equation of state of reactor materials at high pressures and temperatures, a modified equation of state for hydrodynamic calculations in the AX-1 numerical program, properties of refractory ceramics at extremely high temperatures (UC liquid expansion), modification of the high temperature W filament furnace, failure pressures of thick-walled doubly-reinforced concrete cells, maximum permissible body burdens of Pu isotopes and resulting release criteria, fast reactor meltdown accident analysis code, PREAX; experimental physics techniques and facilities including a low geometry α counting chamber, absolute determination of fission rates in ^{235}U and ^{238}U and capture rates in ^{238}U by radiochemical techniques, precision fission rate measurements by fission track counting, solid-state Compton spectrometer for measurement of reactor γ spectra, feedback stabilization of nuclear counting channels, signal splitting into fast and slow channels, design and construction of an improved Mn bath counting system, low flux measurement of ^{238}U epicadmium capture-to-fission ratio, reactor response to an oscillating neutron source, neutron fluxes required for activating probe materials, a code to permit fission product decay corrections without the use of a reference foil, determination of the k-constant for the Dy substitution method, additional calculations of the activation of spheres in a nonisotropic neutron flux, use of a small digital computer in data analysis and control of critical facilities, a Ge(Li) detector system for the measurement of γ-rays following inelastic neutron scattering, a multi-angle fast neutron time-of-flight system, multiple angle detector apparatus for neutron elastic scattering and polarisation measurements, multiple scattering correction, automated computed control of a fast neutron laboratory; reactor computation methods and theory including the Argonne Reactor Computation (ARC) system, the ARC system glossary, the Multigroup Constants Code (MC^2), modification of THERMOS to generate transfer cross sections, generation of multigroup cross sections using a coupled MC^2-THERMOS code, variation of thermal cross sections with buckling in consistent P1 and B1 calculations, development of a code to study fuel management, AMC-A Monte Carlo code, development and analysis of Monte Carlo methods, quasistatic treatment of space dependent reactor transients, space dependent kinetic calculations using the WIGLE code, reactor systems analysis and hybrid computers, computation of the coupled error function by continued fractions, treatment of source discontinuities in the solution of the diffusion equation, revision of the bulk shielding code MAC for the CDC-3600 computer, codes for analysis of elastic scattering angular distributions, multilevel cross sections for a fissionable isotope, the effect of interference on the resonance integral mixtures of Th and U, the effect of randomness on group cross sections, the chemical binding effects on the resonance line shapes of ^{238}U in a UO_2 lattice, equivalence between homogeneous and heterogeneous resonance integrals in cylindrical geometry, effect of the fluctuations in collision density on fast reactor Doppler effect calculations, an approximate calculation of space dependent flux using a variational principle, neutron-wave analysis; miscellaneous including energy spectrum of fast cosmic-ray neutrons near sea level, a CO_2 system for direct conversion of nuclear energy to coherent laser light, theory of plasma oscillations-generation of thermionic RF energy and interactions with DC, circulating shield reactor for space power, and improvised shutter design for the JANUS reactor. A total of 609 references is listed throughout the report. (M.L.S.)

30092 (ANL-7214) HYDRODYNAMICS OF A NEW CONCEPT OF PRIMARY CONTAINMENT BY ENERGY ABSORPTION. Sorensen, H. C.; Fistedis, S. H. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 141p. Dep. CFSTI.

To determine the effect that the destructive component of a nuclear accident produces on a primary containment structure, a fluid dynamical analysis is made for an idealized reactor system having spherical symmetry. This structure consists of the utilization of the concrete biological shield as an energy-absorbing device. For this purpose, unbonded, unstressed, high-strength steel strands are embedded in the biological shield. The new containment concept is based on the energy-absorbing capability of the strands. The partial differential equations describing the fluid motion are based upon the von Neumann-Richtmeyer artificial-viscosity technique and are presented in Lagrangian form. A numerical solution based upon finite-difference approximations of these partial differential equations is obtained by the use of a CDC-3600 digital computer. All computer programs used in obtaining the numerical solution are written in FORTRAN IV computer language. A solution for an ideal reactor system that does not include the reactor vessel is given along with a solution for the same ideal reactor system but with the reactor vessel included. In each case, the effect that the destructive component produces on the concrete containment structure is determined from the computer results and is discussed. The results of the two solutions are then compared. Suggestions for improvements in the analysis and suggestions for future work are also mentioned. (auth)

30093 (ANL–7317) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, MARCH 1967. (Argonne National Lab., Ill.). Apr. 28, 1967. Contract W-31-109-eng-38. 124p. Dep. CFSTI.

The EBWR was operated at the maximum permissible power level of 70 MW. During the approach to power, pile-oscillator measurements of the reactor transfer function were made at 28, 38, 49 and 57 MW. In preparation for Run No. 25, several zero-power reactor runs were made to obtain measurements of reactivity worth of the stainless steel subassemblies in Rows 7 and 8, which have replaced subassemblies of depleted U. An extensive program of analysis was initiated to determine the sources and extent of Cu found in the reactor primary Na system. Removal of the Cu electrodes associated with the auxiliary primary pump showed that the exposed Cu ends were severely pitted and eroded and had indeed lost Cu to the primary Na. The exposed Cu ends of the electrodes were sheathed in stainless steel and the electrodes were reinstalled. The pump was checked out and is operating satisfactorily. Analysis for further sources of Cu in the primary system is continuing and results are being evaluated. Postirradiation examination of radial-blanket subassemblies from the 7th, 8th, 9th, and 12th rows of the reactor revealed that length, diametral, and density increases were greatest for the innermost rows, decreasing along the radius from the core, with no significant increases noted for the 9th or 12th row subassemblies. Concrete for the ZPPR cell floor and pit and for the blanket storage room floor was poured. Experiments are in progress with ZPR-3 Assembly 48B, a reactor with a two-zoned Pu core and with a 12 × 15-in. central region that contains Pu with 22% ^{240}Pu substituted for 4.5% ^{240}Pu. Critical mass was determined after control-rod calibrations were made as well as measurements of the worth of core-edge material and of fuel spiking of the safety rods. In the high-Pu-content central region, measurements were made of Na substitutions, fission ratios, perturbation reactivity measurements with small samples, and of fine flux variations across the cell. ^{235}U fission ratios were measured versus ^{233}U, ^{234}U, ^{236}U, ^{238}U, ^{239}Pu, and ^{240}Pu. Reaction rate traverses were made in a radial direction at the core midplane and reactivity traverses have been made in the radial direction using stainless steel, Ta, ^{10}B, ^{235}U, ^{239}Pu, and ^{238}U. Work on an improved proton recoil neutron spectrometer is also reported. Work done to define more narrowly the limits of precision of ZPR-3 experiments by refinement of measurements related to the ZPR-3 gap interface is reported. (J.R.D.)

30094 (APDA-CFE–3) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 3, October 1966. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). May 1967. Contract AT(11-1)-865. 40p. Dep. CFSTI.

An operations history of the Fermi Reactor is given. The operating conditions of the various systems are discussed. A detailed discussion of the fuel damage occurring on October 5, 1966 is given. A tabulation of detector readings at this time is given. Reactivities for various central fuel subassemblies are listed. Results of flow tests and subassembly outlet thermocouple readings are detailed. Shield temperature measurements and shielding evaluations are discussed briefly. (M.L.S.)

30095 (APDA-CFE–4) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 4, November 1966. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). May 1967. Contract AT(11-1)-865. 37p. Dep. CFSTI.

An operations history of the Fermi Reactor is given. Repairs and modifications to the plant system are outlined. Those systems affected are: primary Na pumps, secondary Na pumps, reactor safety systems, fuel handling equipment, steam generators, raising of the reactor hold-down mechanism, operation of the reactor sweep mechanism, and core investigation using the offset handling mechanism. The nuclear and plant test programs are discussed briefly. (M.L.S.)

30096 (APDA-CFE–5) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 5, December 1966. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). May 1967. Contract AT(11-1)-865. 32p. Dep. CFSTI.

A detailed description of the Fermi Reactor fuel unloading and fuel handling experience and procedures is given. The Na and gas systems performances are discussed. Pu production and core-integrated Na flows are treated briefly. A detailed description of the core investigation is presented. Results of a study of particulate matter in the Na coolant and subassembly pin clad damage tests are discussed briefly. A fuel inspection facility and shipping cask design are given. (M.L.S.)

30097 (APDA-CFE–6) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 6, January 1967. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). May 1967. Contract AT(11-1)-865. 30p. Dep. CFSTI.

Plant operations at the Fermi Reactor are summarized briefly. A detailed description of the core investigation being conducted after the fuel damage incident is given. Results of examinations of various subassemblies and techniques used are discussed. Possible steam generator modifications are outlined. (M.L.S.)

30098 (APDA-CFE–7) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 7, February 1967. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). May 1967. Contract AT(11-1)-865. 27p. Dep. CFSTI.

Plant operations at the Fermi Reactor are summarized. A description of the core investigation being conducted following the fuel damage incident is given. Results of examinations of various subassemblies are discussed. (M.L.S.)

30099 (BAW–3647-4) PHYSICS VERIFICATION PROGRAM. PART II. Quarterly Technical Report, January–March 1967. Clark, R. H.; Baldwin, M. N. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). June 1967. Contract AT(30-1)-3647. 48p. Dep. CFSTI.

A program for determination of response of startup detectors for use with large, central-station pressurized water reactors is described. The driving facility for the instruments is detailed. Response of the instruments in both shielded and unshielded conditions is tabulated. Characteristics of the various instruments available from different manufacturers are summarized. The neutron flux profile of the core is presented in detail. (M.L.S.)

30100 (BLG–119(Rev.1)) THE CHOICE OF THE OPERATIONAL PARAMETERS OF THE BR2 REACTOR HOT SPOT FACTORS. First Part. Minsart, G.; Dopchie, H.; Fouarge, L. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Jan. 1964. 40p. Dep.

A correlation between the parameters determining the operation level of the BR2 reactor is attempted. The calculation is based on preliminary measurements of neutron flux distribution in a core mock-up facility, BR02, and the fuel element specifications. The limiting condition may be expressed as follows: maximum permissible plate temperature = water saturation temperature + superheat. The hot channel factor and hot spot factors are defined, and an estimate of the numerical value is given for each of them. (auth)

30101 (BNL–50010) BEHAVIOR OF FUEL CLADDINGS UNDER LOAD AND WITH THERMAL CYCLING IN SODIUM. Susskind, H.; Becker, W. (Brookhaven National Lab., Upton, N. Y.). June 1966. 22p. Dep. CFSTI.

Out-of-pile screening tests were carried out in support of the

Ordered Bed Fast Reactor program. Investigation of the effects of static loading on particle interaction for different fuel cladding compositions and of thermal cycling on fuel ball attrition caused by movement between adjacent balls and balls on the container walls in pure, high-temperature sodium were made. Fourteen different claddings, including a potential cermet fuel, were either obtained commercially or fabricated. The claddings were subjected to static compressive loads in excess of those existing in a typical full-size OBFR, in purified sodium, usually at 700°C, or 50° above the proposed reactor operating temperature, for periods of ≈1 week. The special cermet fuel did not sinter. The presence of deoxidants such as Ti, Nb, Al, and Mo in types 300 and 400 stainless steels (SS) prevented sintering. Thus, while almost all type 304 and 410 SS balls sintered, their respective Cr–Ni analogs of types 321 and 347 SS did not. Neither did type 405 SS or type 316 SS, which contains Mo. Pure Cr sintered. Solid-solution alloys of Al and Fe and Al and V, which promoted the formation of a protective Al_2O_3 film, did not sinter. The thermal cycling studies were carried out for 565 hr in a pumped stainless steel loop with type 316 SS balls packed in a mild steel test column, but with no external compressive load. Relative bed motion was induced by varying the sodium temperature between 290 and 650°C. Radiographs showed conclusively that a bed of spheres packed in geometric order will move without becoming disordered, and that this process is reversible. (auth)

30102 (BNL–50016) PRESSURE DROP IN GEOMETRICALLY ORDERED PACKED BEDS OF SPHERES. Susskind, H.; Becker, W. (Brookhaven National Lab., Upton, N. Y.). June 1966. 70p. Dep. CFSTI.

Measurements were made of the pressure drop of water flowing through a full-size Ordered Bed Fast Reactor (OBFR) fuel element packed with stainless steel ball bearings in an ordered geometry. Experiments were carried out with 11 different packed beds in the same 10.85 × 10.85 × 30-in. test column in a forced circulation loop at Reynolds numbers up to 17,000. The test variables included water velocity, bed voidage, spacing between adjacent balls, ball diameter, and bed height. Curves of friction factor vs Reynolds number were plotted for each bed, encompassing the entire range of the square-base rhombohedral packing array selected for the OBFR. In addition, the results were corrected for wall effects, and these curves are also presented. An increase in the relative horizontal spacing of balls, which determines the size of continuous flow channels through the bed, has a very significant effect in decreasing the pressure drop, becoming more pronounced as the spacing increases, especially past the minimum packing density. Data may be corrected for bed voidage over small variations in ball spacing by the ratios of $(1-\epsilon)/\epsilon^3$ at the two voidages. The friction factor curves are not all the same shape. In the absence of an adequate expression showing the mutual effects of both bed voidage and ball spacing, the system appears to consist of two distinct parts, separated at the minimum packing density. The first part, lying between ball spacings of 1.000 and 1.155 ball diameters, was correlated, but only moderately well, by the expression $f\epsilon^3/(1-\epsilon) = 83.4\ [(1-\epsilon)/\mathrm{Re}] + 0.42$. No correlation for the second part, lying between ball spacings of 1.155 and 1.225 ball diameters, was found. Entrance and exit effects could not be measured beyond the first seven ball layers; ball diameter and ball spacing did not influence the results. (auth)

30103 (BNWL–400) REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES QUARTERLY REPORT, OCTOBER, NOVEMBER, DECEMBER 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 15, 1967. Contract AT(45-1)-1830. 66p. Dep. CFSTI.

Thermalization theory integral formulation is presented; single particle wave functions describing low energy elastic scattering by target nuclei of He and O are described. A computer program, BROAD, for direct calculation of temperature dependent cross sections has been written. Modifications were made to UNICORN, HRG, TEMPEST, ZODIAC 2, ZODIAC 3, and ZODIAC F. The computer code OP has been written for shielding studies. CONVRT has been written to convert foil activation data from paper tape to digital computer language. Reactivity coefficients are presented for a Pu fueled light water reactor. A description of the gamma facility used to acquire data from irradiated fuel elements is given. The development of the reactivity technique for determination of effective ^{10}B concentration in samples of borated D_2O is described. The results of critical experiments in the PRCF are given. Results from an extensive set of reactivity measurements of neutron absorbing rods in $PuO_2-UO_2-H_2O$ lattices are summarized. The worth of the HTLTR control rods are given. Comparisons of unzoned and two-zoned concepts for the FTR are detailed. Crystalline binding effects on the FTR Doppler coefficient are discussed. FTR fuel heterogeneity effects are examined. Fast reactor investigations for the FTR are presented. Reactivity measurement techniques using pulsed neutrons are discussed. Analyses of critical experiments in hydrogenous media are given. Crystal spectrometer studies of atomic and molecular motions of water at 268°K and 299°K are presented. Cross section data for slow neutron inelastic scattering in H_2O and D_2O are presented. (M.L.S.)

30104 (BNWL–409) PERT-IV: A TWO-DIMENSIONAL PERTURBATION CODE IN FORTRAN-IV. Hardie, R. W.; Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 87p. Dep. CFSTI.

PERT-IV is a two-dimensional (R-Z, X-Y, R-Θ), first-order perturbation theory code for computing reactivity coefficient traverses, activity traverses, the neutron generation time, and the effective delayed neutron fraction. The input flux and adjoint flux can be taken directly from 2-D calculations or synthesized from 1-D calculations. In a 65 K memory (and 4 tapes), the code can handle 35 materials, 26 energy groups, and a 50 × 50 spatial mesh. Running time on a UNIVAC 1107 is about 3 minutes. Input instructions, a sample case, and a FORTRAN-IV source deck listing are included. (auth)

30105 (BNWL-CC–978) NUCLEAR ELECTRIC PLANT CAPITAL COSTS VS. SITE LOCATION. Kempf, F. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1, 1967. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

The effects of geographic location on nuclear power plant economics are considered. The differential capital costs are analyzed with maximum emphasis placed on siting factors which affect plant construction costs. A summary of direct and capital cost variations is given. Discussion of cost factors, as pertains particularly to local conditions, are presented. (M.L.S.)

30106 (BNWL-SA–738) ECONOMICALLY OPTIMUM PLUTONIUM LATTICES FOR WATER REACTORS. Nail, J. H.; Deonigi, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 28, 1966. Contract AT(45-1)-1830. 20p. (CONF-661001–47). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Significant savings can be obtained from reoptimization of U fuel lattices for PuO_2 fuels. The optimization is significantly affected by PuO_2 composition; combinations of the methods described seem to offer the greatest promise, particularly, for the lattice pitch-rod size combination where the lattice pitch increases could offer significant savings if the specific power can be increased somewhat. Spectral softening can result in significant improvement in Pu value. (auth)

30107 (BNWL-SA–776) SOME NUCLEAR CHARACTERISTICS OF PWR's RECYCLING PLUTONIUM AT MINIMUM FUEL-CYCLE COSTS. Thompson, R. T.; Deonigi, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 28, 1966. Contract AT(45-1)-1830. 20p. (CONF-661001–48). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

The power peaking problems arising from the introduction of recycle Pu into a reactor designed for slightly enriched U are presented. The economics involved in the use of Pu in power reactors are discussed. The initial introduction of Pu into the reactor causes most difficulties. Calculations of power characteristics of various lattice parameters with lattice parameter variations are presented. The effects of the zoning of Pu on the power generation rate are discussed. Effects of varying bundle size, Pu enrichment, and rod enrichment levels are examined. Effects of lattice variation on both void coefficients and reactivity are given. (M.L.S.)

30108 (CEA-R–3114) GUIDE DE CRITICITE. I. INTRODUCTION A LA CRITICITE, II. REGLES PRATIQUES. (Criticality Guide. I. Introduction to Criticality. II. Practical Rules). (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1967. 78p. (In French). Dep.

Elements of neutronics are presented; the "K infinite" and "K effective" formulas are derived and discussed. The limiting solid angle method is explained and some simple formulas proposed for evaluating the interaction between "fissile units." The general principles used in studying the safety of nuclear installations using fissile matter are given. Practical rules, critical mass and critical geometry curves as well as all the numerical values required for normal criticality calculations are given for Pu and U at various degrees of enrichment. The task of specialists is simplified by familiarizing them with the problems the engineers and scientists in charge of the design of installations using fissile matter, and the persons in charge of their operation. (auth)

30109 (CEA-R-3162) EXPERIENCES DE PULSATIONS NEUTRONIQUES SUR LE REACTEUR A GRAPHITE EDF 3. (Pulsed Neutron Experiments on the Graphite Reactor EDF 3). Fuster, Serge; Tarabella, Andre; Tellier, Henry (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 35p. (In French). Dep.

The use of the pulsed neutron technique on the EDF-3 reactor has made possible to calibrate a great number of control elements. This technique, which was tested on EDF-2, has given good results, of which the interpretation is difficult due to the reactor size. As some processes were used to avoid this kind of difficulties, another method for interpreting the results is proposed. (auth)

30110 (CNEA-183) BREVES CONSIDERACIONES SOBRE EL CICLO DE COMBUSTIBLES EN LOS REACTORES DE POTENCIA. (Brief Review of the Fuel Cycle in Power Reactors). Ledanois, Guy; Solanilla, Roberto (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1966. 15p. (In Spanish). Dep.

The use of the fuel elements and the fuel cycle is examined for four types of nuclear reactors: the PWR and BWR light water reactors, heavy water reactors, and graphite reactors cooled by CO_2. An example is also presented of the economic calculation of fuel cycles. (J.S.R.)

30111 (CONF-660206) NEUTRON NOISE, WAVES, AND PULSE PROPAGATION. Proceedings of a Symposium at the University of Florida, Gainesville, February 14–16, 1966. (Florida Univ., Gainesville). May 1967. Contract AT(40-1)-2581. 788p. Dep. CFSTI.

A total of forty papers was presented at the conference. Twenty-two papers were previously abstracted in NSA. Separate abstracts were prepared for 18 papers. (J.R.D.)

For abstracts of individual papers see: 30112–30129.

30112 (CONF-660206, pp 1-19) DEVELOPMENT OF TECHNIQUES OF NEUTRON-WAVE AND NEUTRON-PULSE PROPAGATION. Perez, Rafael B.; Uhrig, Robert E. (Florida Univ., Gainesville).

Neutron-wave and -pulse propagation are special cases of spatial-dependent reactor kinetics. The neutron field is excited with a sinusoidal variation or an impulse at a particular point, and the response to the input throughout the system is measured. The results are interpreted in terms of the nuclear characteristics of the system. The shape of the pulse can be Fourier analyzed to give the frequency components. The impulse input is easier to apply to a nuclear system and introduces many frequencies simultaneously. However, sinusoidal variations concentrate the power of the disturbance into a single frequency. From a theoretical standpoint, these two techniques are substantially equivalent, but both have experimental advantages and disadvantages depending upon the type of experiment and the equipment available. (auth)

30113 (CONF-660206, pp 49-54) PROPAGATION OF THERMAL-NEUTRON WAVES IN HETEROGENEOUS MEDIA. Booth, R. S.; Perez, R. B. (Florida Univ., Gainesville).

Neutron waves are introduced at the boundary of a graphite pile in which thin Cd strips have been placed in a periodic pattern. The experimental results indicate resonance effects in the frequency response of this system caused by backward-directed waves from the perturbing absorbers. The time-dependent one-group diffusion equation is used as a theoretical model. Its solution with a Green's function technique shows that the assumption of a Maxwellian energy distribution does not predict the experiment. It is concluded that the neutron-wave technique can become a powerful tool in the investigation of heterogeneous systems. (auth)

30114 (CONF-660206, pp 55-68) COMPLEX RELAXATION LENGTH OF NEUTRON WAVES IN MULTIGROUP TRANSPORT THEORY. Travelli, A. (Argonne National Lab., Ill.).

A new method is developed for the calculation of the real and the imaginary parts of the complex inverse relaxation length in a homogeneous, uniform, and isotropic medium. The method rigorously applies multigroup transport theory and allows for prompt multiplication and for any degree of anisotropy in the scattering kernel. A two-dimensional continuum of eigenvalues is found, which is the generalization of the continuum that is obtained in the study of the exponential experiment. The continuum is shown to correspond to neutron beams, and its distribution and possible experimental implications are derived. The method is tested numerically for graphite with linearly anisotropic scattering and with various kernels. The results are in good agreement with experimental data. (auth)

30115 (CONF-660206, pp 99-104) GENERAL POLYCHROMATIC TELEGRAPHIST'S EQUATION FOR NEUTRON THERMALIZATION. Booth, R. S. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio).

The energy-, space-, and time-dependent P_1 expansion of the Boltzmann equation is reduced to a coupled set of space- and time-dependent equations by expansion of the energy dependence in eigenfunction of the symmetrized scattering operator. The unique feature of this derivation is that no restrictive assumptions are made about the form of the scattering kernel or the energy dependence of the flux. This technique leads to a numerical solution to the Boltzmann equation by the eigenfunction method, or discrete energy method, introduced by Ohanian and Daitch. (auth)

30116 (CONF-660206, pp 105-15) PROPAGATION OF MONOCHROMATIC NEUTRON WAVES IN FAST, NONMULTIPLYING MEDIA. Ohanian, M. J.; Perez, R. B.; Cockrell, R. G. (Florida Univ., Gainesville).

The general characteristics of the Fourier components of the neutron field excited by the introduction of a burst of fast, monoenergetic neutrons into a nonmoderating and nonmultiplying assembly are studied. In particular, the existence of an asymptotic wave with a discrete eigenvalue is investigated, and it is shown that an asymptotic wave is always obtained for physical systems ($\Sigma_{s0} \neq 0$) of this type. It is also shown that the effect of source beam penetration does not create any difficulties in the measurement of an asymptotic discrete eigenvalue. Numerical results are presented to show the behavior of the dispersion law and the complex inverse relaxation length for the case of a Pb assembly. (auth)

30117 (CONF-660206, pp 135-59) DISPERSION LAW FOR A NATURAL-URANIUM HEAVY-WATER SUBCRITICAL ASSEMBLY. Dunlap, J. H.; Perez, R. B. (Florida Univ., Gainesville).

The dispersion law for thermal-neutron-wave propagation in a rectangular natural U heavy-water-moderated subcritical assembly was obtained by numerical Fourier analysis of a thermal-neutron pulse of low spatial harmonic distortion introduced through one boundary of the assembly. In the frequency range studied, the experimental results for the real and the imaginary parts of the inverse relaxation length were found to increase smoothly with frequency. The dispersion law as determined by experiment was compared with that predicted by two-group theory and by Fermi age diffusion theory. Neither model was found to be wholly acceptable, but Fermi age theory gave somewhat better agreement. Two-group theory failed, especially at higher frequencies, by predicting decreasing phase-shift rates for frequencies above 350 cycles/sec. (auth)

30118 (CONF-660206, pp 161-86) SIMPLE PULSED NEUTRON SOURCE FOR THE NEUTRON-PROPAGATION EXPERIMENT AND ITS APPLICATION TO GRAPHITE SYSTEMS. Sumita, Kenji; Takahashi, Akito (Osaka Univ. (Japan)).

A simple pulsed neutron source was used to carry out neutron-pulse-propagation experiments in a graphite moderator system after the neutrons had been slowed down from the 14.3-Mev energy level by paraffin. Diffusion characteristics were obtained by measuring the time for the peak value of the neutron disturbance to propagate from one point to another. A Fourier analysis of the shape of the propagating pulse and the calculation of the time moment of the pulse gave additional information about thermalization. (auth)

30119 (CONF-660206, pp 187-93) THEORETICAL JUSTIFICATION FOR NEUTRON-PULSE-PROPAGATION EXPERIMENTS IN FAST NONMODERATING ASSEMBLIES. Booth, R. S.; Frankhauser, W. A. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio).

The consistent P_1 approximation to the Boltzmann equation serves as a model for the theoretical study of fast-neutron pulse propagation in nonmoderating assemblies. It is shown that this technique can be used to measure the nonelastic cross section. Its advantages are compared with the die-away technique. Possible methods of data analysis are discussed, and theoretical predictions for Fe are graphically presented with the nonelastic cross section as a parameter. (auth)

30120 (CONF-660206, pp 285-314) NERVA REACTOR TRANSFER-FUNCTION MEASUREMENTS WITH CROSS-CORRELATION TECHNIQUES. Wasserman, A. A.; Steiner, G. H.; Bodenschatz, C. A.; Honka, E. K. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

System transfer functions of several reactor prototypes for the Nuclear Engine for Rocket Vehicle Application (NERVA), were measured by means of noise techniques. Data were analyzed with digital cross-correlation data-processing codes. System transfer functions were derived from measurements made during the NERVA NRX-A2 test series. Measurements were made with pseudorandom signals with noise-level amplitudes which were inserted into the reactor system during steady state holds. Transfer function test data from the NRX-

A3 series were analyzed for the EP-II-FC facility checkout and the EP-IV full power reactor test. Binary pseudorandom signals generated by feedback shift register were applied to turbopump speed demand and/or power demand. The gain and phase of each transfer function were computed from the power spectral density of selected input signal and cross spectral density of input and output signals. (M.L.S.)

30121 (CONF-660206, pp 531-65) FUNDAMENTAL ASPECTS OF STOCHASTIC PROCESSES AND FLUCTUATION PHENOMENA IN FISSION REACTORS. Kemeny, Leslie G. (New South Wales Univ., Kensington (Australia). School of Nuclear Engineering).

Fundamental relations between Brownian motion and neutronic motion are reviewed. For the theoretical analysis of both phenomena, the use of Green's functions and a Fokker–Planck type of equation is found to be mathematically advantageous and physically meaningful. Mathematical models and algorithms are given for the statement and solution of important stochastic problems in fission reactors. Theoretical results are correlated with experimental measurements. On this basis a number of reactor diagnostic techniques are proposed. (auth)

30122 (CONF-660206, pp 623-48) SPACE-DEPENDENT CROSS SPECTRAL DENSITY IN A BARE CUBE. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A space-dependent theory for the reactor noise power- and cross-spectral-density functions is applied to a series of bare cubical reactors. In its present form the method is based upon one-energy-group diffusion theory. The cross-spectral-density function is calculated for both critical and subcritical bare cubes of three sizes. The results are compared with the space-independent theory prediction of the spectral density and a previous space-dependent power-spectral-density calculations. As in the previous work, it was found that, for detector locations away from the axes of symmetry and/or for subcritical systems, the comparison between the two theories is poor. The magnitude of the cross spectral density is found to deviate from that of the power spectral density in most cases, and the phase angle of the cross spectral density was of such size as to probably be measurable over a reasonable frequency range. For the system sizes considered, the space-independent representation is adequate for the critical case and slightly subcritical cases for many detector locations, but, in particular, for large and/or subcritical systems, the shape deviates notably from that of the space-dependent result, and errors in the break frequency can result even when the shape appears correct. Although inclusion of the energy and transport effects reduces the magnitude of the space-dependent effects, it is felt that for certain situations, i.e., for many detector locations in larger subcritical systems, space-dependent effects should not be ignored. A procedure for inclusion of the telegrapher's-equation effects is developed. (auth)

30123 (CONF-660206, pp 503-30) A REVIEW OF NORA PROJECT NOISE EXPERIMENTS. Christensen, H.; Babala, D.; Bergem, T.; Jovanovic, St.; Stormark, E.; Suwalski, W. (Institutt for Atomenergi, Kjeller (Norway)).

Measurements in cores moderated by a mixture of H_2O and D_2O gave indications of spatial effects and of an inadequacy of the Rossi-alpha theory. In later measurements on an H_2O-moderated core, these effects were explored further. Several different techniques (Rossi-alpha, Feynman, power spectral density, and oscillator) have been used to measure the basic kinetic parameters for the same core. The results are tabulated and compared. (auth)

30124 (CONF-660206, pp 381-98) REACTOR NOISE EXPERIMENTS IN REFLECTED PLUTONIUM ASSEMBLIES. Albrecht, R. W. (Washington Univ., Seattle); Hess, G. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Work concerning the dynamic parameters of Pu systems is described. The motivation for performing dynamic measurements is examined, and preliminary experimental results are compared with calculations and shown to exhibit similar trends. The systems being investigated consist of near-cubical cores, approximately 12 in. on a side, constructed in checkerboard fashion of fuel compacts and Lucite blocks. These cores are reflected in one dimension. (auth)

30125 (CONF-660206, pp 315-32) PSEUDORANDOM PULSING OF SUBCRITICAL SYSTEMS. Uhrig, R. E.; Ohanian, M. J. (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences).

The pseudorandom neutron-source excitation method as applied to subcritical systems is described with emphasis on instrumentation and data-acquisition and -analysis techniques. Results obtained for Rossi-alpha and pulse-propagation measurements on the University of Florida Accelerator Pulsed Assembly (UFAPA) are given, and the difficulties in using the method for such measurements are discussed. (auth)

30126 (CONF-660206, pp 487-501) SOME APPLICATIONS OF DYNAMIC (NOISE) MEASUREMENTS IN PRESSURIZED-WATER-REACTOR NUCLEAR POWER PLANTS. Rajagopal, V.; Gallagher, J. M. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

Results of statistical correlation measurements for obtaining information in a complex system are presented. Experiments were performed on three nuclear power plants with conventional plant instrumentation. Inherent fluctuations (noise), response to forced random and sinusoidal and step variations in reactivity were studied. Frequency-domain analysis of the data was performed with a special-purpose analog type analyzer used for determining power and cross spectral densities. Results obtained demonstrate that significant semiquantitative information on the process can be obtained from power-spectral-density analysis of inherent fluctuations and cross-spectral-density techniques permit frequency-response measurements and system-parameter determination in commercial nuclear plants. (auth)

30127 (CONF-660206, pp 333-42) USE OF A PSEUDO-RANDOM SOURCE INPUT IN THE MEASUREMENT OF IMPULSE-RESPONSE FUNCTIONS. Meyer, P.; Garelis, E. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.).

The pseudorandom-impulse-response method, in which a pseudorandom neutron-source input is used and cross correlation between the source input and the reactor output is made, is compared with the pulsed neutron method. Identical results for the prompt decay constant were obtained. A novel digital data-acquisition system for the pseudorandom method is described. (auth)

30128 (CONF-660206, pp 413-38) MEASUREMENT OF SHUTDOWN REACTIVITY IN LARGE GAMMA FIELDS. Schultz, M. A. (Milletron, Inc., Irwin, Pa.).

The conventional narrow-band and wide-band methods of measuring neutrons in the presence of γ fields are described, and a new variation of the wide-band method with the use of multiple detector tubes is presented. A special breadboard B-lined proportional-counter tube to discriminate against γ rays was designed, constructed, and operated with fast-pulse electronic circuits and in an ionization-chamber mode. This detector can be operated successfully as a pulse counter in γ fields above 20,000 r/hr and as an ion chamber in fields up to 10^8 r/hr. Shutdown reactivity measurements were then made with this detector with the use of a two-frequency method. Measurements were successful down to −$5 in reactivity. The Teflon insulation of the detector ultimately deteriorated after a gross irradiation of approximately 10^7 r, and the deterioration terminated the experiments. (auth)

30129 (CONF-660206, pp 439-53) IDENTIFICATION OF TRANSFER FUNCTION OF REACTOR CONTROL SYSTEM BY NOISE ANALYSIS. Kataoka, H.; Kubo, M. (Sophia Univ., Tokyo (Japan). Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa Prefecture (Japan)).

The characteristics of a control system of a nuclear reactor can be identified by the neutron-noise-analysis method. By this method the transfer function of the control system can be analyzed using only the power spectral density of the neutron noise, which is measurable. The characteristics of the control system for several types of research reactors in Japan were analyzed. It is believed that this method is useful for checking the control system of reactors, especially power reactors in operation, without special in-core equipment and for a relatively short measuring time. (auth)

30130 (CVNA-280) CVTR CORE I NUCLEAR OPERATIONS FOLLOW SUMMARY. Nath, Raymond J.; Wyke, Thomas F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). July 1966. Contract AT(30-1)-2289. 154p. Dep. CFSTI.

The operations history of CVTR is analyzed. Comparisons are made between design calculations, made by the TURBO code and the analytical models, and measured values. Variations between predicted and measured values of core lifetime, power distributions, control rod worths, reactivity worths, and xenon density are discussed. Instrumentation performance and difficulties incurred are considered. (M.L.S.)

30131 (EUR-3462.i) CENTRALE ELETTRONUCLEARE DI LATINA RELAZIONE ANNUALE, 1966. (Latina Nuclear Power Plant Annual Report, 1966). (Ente Nazionale per l'Energia Elet-

trica, Latina (Italy)). Apr. 1967. Contract 002-61-12 REPI. 64p. (In Italian). Dep.

The experience of the third year of Latina plant operation is presented. Data are given on the electricity production and on the availability and utilization of the plant. The absorber cycles and fuel cycles are discussed. Chemical control of the primary coolant, conditioning of boilers, and treatment of radioactive effluents are detailed. Activity level controls, plant contamination, and personnel exposure are discussed. (M.L.S.)

30132 (EUR-3465.e) DETERMINING THE REGION OF ASYMPTOTIC STABILITY OF A COUPLED REACTOR WITH LINEAR POWER FEEDBACK. Schwalm, D. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Apr. 1967. 36p. (CONF-670107-8). Dep.

From American Nuclear Society, Coupled Reactor Kinetics Conference, College Station, Tex.

The region of stability in state space is studied for a two core system by means of Liapunov's direct method. In the case where there is power feedback the dynamical equations are nonlinear. For the linearized system, Liapunov functions are constructed by three different techniques and applied to the nonlinear system. Thus the region of stability in state space can easily be estimated in the two dimensional case. The effect of delayed neutrons on the stability behavior is also studied. This leads to a problem of at least three dimensions. For the case of constant power feedback transfer functions it is shown in special numerical examples that the regions of stability in parameter and state space remain unchanged for vanishing disturbances of the initial conditions of the precursors. (auth)

30133 (EURAEC-1826) SAXTON PLUTONIUM PROJECT. Quarterly Progress Letter for the Period Ending March 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). May 1967. Contract AT(30-1)-3385. 17p. Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A nuclear analysis of the operating performance of the Saxton Core II is given. The just-critical concentration of B is shown as a function of core operation. Effective axial buckling is given as a function of burnup. Lumped fission product cross sections for U and Pu are shown. (M.L.S.)

30134 (EURAEC-1843) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Quarterly Report No. 12. (Ente Nazionale per l'Energia Elettrica, Latina (Italy)). Apr. 1, 1967. Contract 101-63-11-RD-I. 11p. (EUR-3360). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A summary of work done at the Garigliano Power Reactor is given. The work done in preparing new computer programs and the continuing efforts on existing programs are listed. Operation of the instrumented assemblies is discussed. A study of core potential has been started to determine thermal and physical limitations on a future increase in reactor output. Stability analyses of rod oscillation tests are discussed at length. (M.L.S.)

30135 (EURFNR-215F) TERM-1 PROGRAM SYSTEM. Gmelin, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug. 1966. 76p. (KFK-462). Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A description of the TERM-1 system is presented. TERM-1 is a management system for scheduling control in supervision of projects. The most important deadlines are determined from the network plan input; from this the most important activities are determined. The application of this program to fast breeder reactor research is discussed. (M.L.S.)

30136 (EURFNR-287) THIRD FORATOM CONGRESS, LONDON. INDUSTRIAL ASPECTS OF A FAST BREEDER REACTOR PROGRAMME. German Contributions to Sessions I, II, III, IV, VI. Gupta, D.; Haefele, W.; Kummerer, K.; Stegemann, D.; Smidt, D.; Seetzen, J. (Kernforschungszentrum, Karlsruhe (West Germany)). Mar. 1967. 96p. (KFK-546). Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A discussion of the development program for the fast breeder reactor is given. The general considerations, fuel requirements, and operations are discussed. A time scale for development and the characteristics of power reactors are presented. Fuel fabrication and reprocessing are considered from the accountability and economics aspects. The experimental programs being conducted in Europe are discussed at length. Prototype designs for the Na-cooled and steam-cooled reactors are detailed. The economic factors in European fast reactor development are evaluated. (M.L.S.)

30137 (EURFNR-289) CONTAINMENT OF A LARGE SODIUM-COOLED FAST BREEDER REACTOR. Gast, K.; Schikarski, W. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb. 1967. 16p. (KFK-547). Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A practicable model for analysis of containment leakage, after excursion, is proposed for Na-cooled fast breeder reactors. A conceptual design study of a 300 MW(e) prototype is made to illustrate that use of double-containment precludes environmental hazard. (M.L.S.)

30138 (GA-7934) LATTICE PHYSICS STUDIES. Quarterly Progress Report for the Period Ending March 31, 1967. Trimble, G. D.; Gozani, T.; Neill, J. M.; Orphan, V.; Preskitt, C. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 11, 1967. Contract AT(04-3)-167. 85p. (EURAEC-1840). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A facility for measurement of neutron spectra in tightly packed lattices was performance-tested. Foil activation analyses and time-of-flight spectral measurements were made in erbium nitrate. k_{eff} and dieaway time for the first experimental lattice was calculated. The possible use of a pressure vessel for elevated temperature measurements was evaluated. (M.L.S.)

30139 (GEAP-5036) DEVICES FOR CYCLIC AND TRANSIENT POWER CONTROL IN A STEADY-STATE NEUTRON FLUX GRADIENT. Bohm, P. A.; Wilkinson, L. E.; Field, J. H.; Morissette, R. P. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). Aug. 1966. Contract AT(04-3)-540. 12p. Dep. CFSTI.

Three devices are described which permit selective alteration of the thermal neutron flux impinging on an experimental assembly. The devices are applicable to situations where neutron flux variations are in the vertical and horizontal directions. The flux can be flattened, smoothly and repeatedly cycled between wide limits, and also repeatedly cycled in step fashion between wider limits. Results of operation of these devices are described. (auth)

30140 (GEAP-5307) DESIGN AND TESTING OF SOLENOID AND INSTRUMENT LEAD CONNECTOR FOR USE IN SEFOR REACTOR VESSEL. Craig, E. R.; Fulton, R. H.; Damon, J. J. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Mar. 1967. Contract AT(04-3)-540. 26p. Dep. CFSTI.

The design and testing of a multipin lead connector for the SEFOR instrumented fuel assembly and the testing of a solenoid for the instrumented fuel assembly lifting fixture are described. Tests in a Na-vapor Ar environment at temperatures up to 400°F demonstrated that the operational performance of the components would meet or exceed the anticipated requirements for the SEFOR operation. (auth)

30141 (GEAP-5416) EXAMINATION AND EVALUATION OF RUPTURE IN EVESR SUPERHEAT FUEL ROD WITH 0.012-INCH-THICK INCOLOY-800 CLADDING. Rabin, S. A.; Atraz, B. G.; Bader, M. B.; Busboom, H. J.; Hazel, V. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Jan. 1967. Contract AT(04-3)-189. 72p. Dep. CFSTI.

Design, fabrication, and operation data for the Mark III EVESR nuclear superheat fuel are given. Post-irradiation inspection data on the prematurely failed wall-rod are presented. It is determined that the peak power rod had ruptured in the region of maximum power and cladding temperature. (M.L.S.)

30142 (GEAP-5442) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 11, November 1966-January 1967. Horst, K. M. (comp.) (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 1967. Contract AT(04-3)-540. 86p. Dep. CFSTI.

The experimental program to be conducted at SEFOR is described. Results of the fuels development program are discussed. Developments in special instrumentation are presented. The steady-state and transient characteristics of the core assembly are detailed; reactivity controls required for experimentation are discussed. Fuel handling and testing facilities and procedures are outlined. Core design parameters are examined. Fuel fabrication is briefly discussed. (M.L.S.)

30143 (GEAP-5487) POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM. Progress Report No. 3, January 1-March 31, 1967. Lees, E. A. (General Electric Co., Pleasan-

ton, Calif. Nuclear Technology Dept.). Apr. 1967. Contract AT(04-3)-189. 29p. (EURAEC-1860). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Irradiation testing of six fuel assemblies of high performance UO_2 was performed in the Big Rock Point Power Reactor. The fuel rods were clad with Zircaloy-2 tubing. Results of computer calculations of cladding and UO_2 temperature, and thermal expansion are given. The results of critical heat flux analysis are tabulated. The equipment necessary to conduct the tests is being fabricated. (J.C.W.)

30144 (HN-185(Vol.1)) AN ANALYSIS OF NUCLEAR POWER PLANT OPERATING AND SAFETY EXPERIENCE. Garrick, B. J.; Gekler, W. C.; Pomrehn, H. P. (Holmes and Narver, Inc., Los Angeles, Calif. Nuclear Div.). Dec. 15, 1966. Contract AT(04-3)-587. 118p. Dep. CFSTI.

The summary and conclusions of the study of operating and safety experience in five major nuclear power plants are given. Various aspects of the reliability techniques which were used are discussed. (M.L.S.)

30145 (HN-185(Vol.2)) AN ANALYSIS OF NUCLEAR POWER PLANT OPERATING AND SAFETY EXPERIENCE. Garrick, B. J.; Gekler, W. C.; Pomrehn, H. P. (Holmes and Narver, Inc., Los Angeles, Calif. Nuclear Div.). Dec. 15, 1966. Contract AT(04-3)-587. 949p. Dep. CFSTI.

Issued in two books, but cataloged as a unit.

Operating and safety experience in five major nuclear power plants was studied to seek answers and provide data on what experience says about nuclear safety. The plants examined were Dresden-1, Yankee, Indian Point-1, Humboldt Bay Unit No. 3, and the Shippingport Atomic Power Station. Information provided for each facility includes a facility description and review of general operating experience, a discussion of management and maintenance practices, and a review of operating experience and reliability in control, safety, and engineered safeguard systems. (auth)

30146 (IDO-17213) STEP PROJECT. Quarterly Technical Report, July 1966-September 1966. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1967. Contract AT(10-1)-205. 82p. Dep. CFSTI.

The specific heat of the fuel was obtained. An analytic-expression consisting of a linear temperature-dependent term and an Einstein oscillator model temperature-dependent term was developed. The power distribution, effective neutron lifetime, and effective delayed neutron fraction were calculated for the LOFT reactor. Analytical models for predicting release, transport, and deposition of fission products in LOFT were investigated. The computer program BURST-I for calculating acoustic wave phenomena during blowdown was used to calculate the magnitude and duration of transient thrust forces during the subcooled blowdown following a maximum break at the LOFT reactor vessel inlet nozzle. Laboratory data for the penetration of iodine into coatings were compared with calculated results based on simple diffusion of iodine into a semi-infinite solid. Top blowdown tests were performed at elevated temperatures and pressures. (M.L.S.)

30147 (IDO-17214) STEP PROJECT. Quarterly Technical Report, October-December 1966. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1967. Contract AT(10-1)-205. 32p. Dep. CFSTI.

The results of tests to determine the effects of reactor internals on blowdown behavior are presented. Data from high-temperature semi-scale blowdown tests were used to evaluate the capability of the BURST-I computer program for predicting blowdown behavior in the subcooled region. Results of LOFT radiological studies on plateout are presented. Fission product generation was measured during the contamination-decontamination experiment. The continuous sampler-monitor was laboratory tested to determine its efficiency for methyl iodide removal. I_2 adsorption on protective coatings, and the percent of I_2 removed from the atmosphere were calculated for LOFT conditions. Chemically removable coatings were studied as a means of decontaminating the interior of the LOFT containment building. (M.L.S.)

30148 (IDO-17237) FISSION PRODUCT BEHAVIOR LITERATURE REVIEW. Good, E. G. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1967. Contract AT(10-1)-205. 24p. Dep. CFSTI.

A literature survey was made of the data available on fission product release, transport, and deposition. The report presents a bibliography of the literature which appears applicable to the development of analytical methods for calculating the fission product behavior following a loss-of-coolant accident involving a water-cooled, UO_2 fueled reactor. Experimental and theoretical work has been directed toward determining fission product behavior. Much of this information, however, will be of little value in the development of analytical models for LOFT. The release data of fission product noble gases to the void space between the cladding and the fuel pellets during routine reactor operation are sufficient. The mechanism of fission gas release has not been definitely established but enough experimental results exist to provide an adequate basis for preliminary LOFT calculations. Additional data are needed concerning the release of fission products other than noble gases. Applicable data on fission product release from molten fuel and release during heatup to the fuel melting point are limited. Most of the work on transport and deposition in high-temperature gas streams has been directed toward the gas-cooled reactor program. Some of the theoretical work may be adaptable to the LOFT analysis. Once fission products enter the containment building they may undergo agglomeration, settling, diffusion, transport due to convection, adsorption, desorption, and change in chemical form. The containment vessel experiments measure the combined results of several phenomena which occur simultaneously, thereby making interpretation of the results and extrapolation to other conditions difficult. Mathematical models will aid in separating the effects of different variables and allow extrapolation. Thus mathematical models must be developed and checked with additional experiments before extrapolation to LOFT conditions can be accomplished with any degree of certainty. (J.C.W.)

30149 (JAERI-1123) DIRECT SUBSTITUTION OF PLUTONIUM IN COMMERCIAL BOILING WATER REACTOR. Yasukawa, Sigeru; Uematu, Kunihiko; Yumoto, Ryozo (Japan Atomic Energy Research Inst., Tokyo). July 1966. 40p. (In Japanese). Dep.

Some fundamental problems, which occur when Pu fuel is substituted into a boiling water reactor core, are analyzed by a nuclear-thermo-hydromechanics coupled calculation. Results obtained are: Pu fuel uses in thermal reactors can be divided into the direct substitution, the burner utilization, the breeder utilization, the crossover system, and the Pu-Th system. The possibility of direct substitution of Pu into commercial boiling water reactors has been confirmed by analysis of the characteristics of these cores. The most suitable lattice for Pu use is probably a slightly overmoderated one because of the negative void reactivity effect at initial burnup. The lattice should be moderated to prevent recovery of this negative void reactivity with fuel burnup. (M.L.S.)

30150 (JAERI-1128) CROWN: AN IBM-7090 CODE FOR CALCULATION OF CRUCIFORM CONTROL ROD WORTH FOR MONOENERGETIC NEUTRONS. Fukai, Yuzo (Japan Atomic Energy Research Inst., Tokyo). Dec. 1966. 28p. Dep.

A cruciform control rod worth for monoenergetic neutrons can be exactly calculated by a new collision probability method. First a homogenized medium which consists of fuels and moderator and surrounds the cruciform control rod is divided up into a number of identical cylinders with a square cross section. After collision probabilities for the two-dimensional x-y system are calculated, solving a neutron balance equation with an averaged neutron flux for each mesh cylinder, a flow-in current to the control rod and various physical nuclear properties are obtained. An IBM-7090 code—CROWN—for this calculation is programmed in FORTRAN-II and FAP. Restricted conditions for this code are (macroscopic total cross section of the homogeneous medium) × (mesh width) ≤ 2.5 and total mesh numbers ≤ 120, and it can be run by the FORTRAN monitor system with two additional tapes, A5 and B5. The detail calculating method for this problem is first represented, and the content of the CROWN code is described. The numerical table of exact values for the collision probabilities, P_{00}, P_{10}, and P_{11}, is included. (auth)

30151 (KFK-530) UEBERLEGUNGEN ZU SCHWEREN REAKTORUNFAELLEN (ANSAETZE ZU EINER NEUEN QUANTITATIVEN UNFALLPHILOSOPHIE). (Reflections on Serious Reactor Accidents (Statement on a New Quantitative Accident Philosophy)). Schikarski, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jan. 1967. 12p. (In German). Dep.

The concept of the maximum credible accident imported with construction of American reactors in Germany was a helpful safety concept only so long as reactors smaller than medium output were considered. In the present phase of the construction of large units, connected with the breakthrough on the economy and the trend toward population centers, significant difficulties of the maximum credible accident concept appear. The desired extensive independence of the site of the large nuclear power installations being built is only possible through the application of engineered safeguards which consider only insufficiently the maximum credible accident concept. Accidents are extraordinary events for which consequences are probably of significance. Both the individual events in accidents as well as the functioning or failure of safety

devices are to be assigned probabilities. In the maximum credible accident concept this is not possible. In the base accident concept a conservative base accident and the endangering potential is first determined. By assignment of probabilities to accident events and to engineered safeguards, quantitative assumptions on the safety of a reactor, and, therefore safety comparisons of various reactors, can be made. By quantitative estimations on probabilities the indistinct magnitudes of the maximum credible accident can be replaced by the concept of safety risks which is given by the product of the endangering potential and the pertinent probabilities. The safety technical evaluation of engineered safeguards was put on a quantitative basis. The base accident concept permits a way of analyzing the economy of reactor safety. (tr-auth)

30152 (KFK-569) PROSPECTS OF PLUTONIUM FUELED FAST BREEDERS. Gupta, D.; Haefele, W.; Jansen, P.; Seetzen, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb. 1967. 21p. Dep.

Various aspects of the Pu fueled fast breeder reactors are considered. Both the short-term and long-term criteria for Pu fast reactor systems are examined. Comparisons of various types of fast Pu breeders are given. (M.L.S.)

30153 (LA-3556(Rev.)) ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Revised Feb. 1967. Contract W-7405-eng-36. 541p. Dep. CFSTI.

Intended to advance the technology of gas cooled reactors, the Ultra High Temperature Reactor Experiment (UHTREX) is designed for the operation of a graphite-moderated, He-cooled reactor at a thermal power of 3 MW and a maximum gas temperature of 2400°F. The small graphite fuel elements containing enriched U operate in direct contact with the coolant and can be loaded or unloaded while the reactor is operating. The UHTREX facility design and operating plans are described. From analyses of postulated accidents and evaluation of safety features, it is concluded that the UHTREX facility can be safely operated. (auth)

30154 (LA-3683) DEVELOPMENT OF CALCULATIONAL METHODS FOR FAST REACTOR SAFETY ANALYSIS AT LASL. Anderson, Carl A. Jr. (Los Alamos Scientific Lab., N. Mex.). Apr. 24, 1967. Contract W-7405-eng-36. 22p. Dep. CFSTI.

A method for computer analysis for a maximum credible accident for a fast reactor is presented. Safety problems, which are likely to be incurred in normal operation, are discussed. Methods of treatment of these are presented. Sample calculations of core characteristics are given. (M.L.S.)

30155 (LA-DC-8398) OPERATION OF THE PLUTONIUM-FUELED FAST REACTOR LAMPRE. Peterson, R. E.; Cubitt, R. L. (Los Alamos Scientific Lab., N. Mex.). [1967]. 14p. (CONF-670413-2). Dep. CFSTI.

From National Topical Meeting on Fast Reactors, San Francisco, Calif.

Adequate coolant purity was maintained in the LAMPRE system so that a refractory metal container for the fuel could be satisfactorily used. N from the atmosphere was observed to diffuse into the coolant loop through the pipe walls, which operated at 450 to 650°C; the N concentration in the gas space above the Na was controlled by periodic flushing, and no ill effects attributable to the N were observed. During the course of the experiment, fission products and Pu were released into the coolant loop. This had only a minor effect on the established procedures for reactor operation, fuel handling, etc. The distribution of fission products in the system was not examined in detail, because not all of the loop was accessible to γ scanning equipment. Where measurements could be made, the results—particularly with respect to Cs—are consistent with fission product transport and distribution observed in laboratory experiments. A major part of the core structure, and some of the coolant loop, was disassembled after the conclusion of the reactor experiment. This was accomplished without particular difficulty. The level of dispersible Pu contamination was lower than had been expected. In the hot trap system, Pu contamination was firmly fixed on the pipe walls; sections of these components were removed from the loop without any special techniques to prevent the spread of radioactive materials. The larger sections of gas piping attached to the top of the reactor vessel contained detectable levels of Pu, but conventional bagging techniques were adequate to permit uneventful disassembly of the system. Smaller gas lines connected to the fuel charging machine were safely removed without bagging. (auth)

30156 (NP-16750) OCTOBER 5, 1966 FUEL DAMAGE INCIDENT AT THE ENRICO FERMI ATOMIC POWER PLANT. Status as of February 24, 1967. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich.). 121p. Dep. CFSTI.

A report of the fuel meltdown at Fermi Fast Breeder Reactor is given. Occurrences which led to the discovery of the meltdown are given. Methods used to assure containment of fission products are described. The testing done to identify the cause of the meltdown and results of these tests are detailed. (M.L.S.)

30157 (NUS-TM-S-35) CONTAINMENT AIR PARTICULATE ACTIVITY IN ELK RIVER REACTOR. Smith, E. R. (NUS Corp., Washington, D. C.). Aug. 6, 1966. 5p.

The current alarm point for the plant-particulate-monitor immediate β-γ activity detector is 3×10^{-10} μC/cc. Under existing conditions the monitor is nearly always in the alarm condition because of the low set point. A review of data obtained from high volume air samples collected within containment shows that the particulate activity is composed of naturally occurring radionuclides and fission product daughter ^{88}Rb and ^{138}Cs. The MPC_A for radiation workers for ^{88}Rb and ^{138}Cs is 1×10^{-6} μC/cc. A new alarm point of 6×10^{-8} μC/cc should be used for the plant immediate particulate monitor. This alarm point is 10% of the MPC_A calculated for a whole body exposure of 0.1 Rem/wk from an equilibrium mixture of ^{88}Kr and ^{88}Rb. (auth)

30158 (NYO-3280-1(Vol.2)(Bk.1)) PM-3A NUCLEAR POWER PLANT DESIGN ANALYSIS REPORT. Andonedis, A. (Burns and Roe, Inc., Oradell, N. J. Nuclear Engineering Dept.). Jan. 1967. Contract AT(30-1)-3280. 390p. Dep. CFSTI.

Stress analyses of major piping systems and components of the PM-3A plant are presented. Those systems or components examined are: reactor pressure vessel, steam generator code calculations, discontinuity analysis of steam generator tube-sheet/shell-channel assembly, steam generator tube-sheet/shell-channel assembly fatigue analysis, steam generator steam outlet nozzle for applied pipe loads, steam generator feedwater inlet nozzle for thermal transient analysis, reactor coolant pumps, reactor coolant piping, pressurizer, pressurizer spray line piping, pressurizer relief line, purification demineralizer, purification demineralizer and decay heat piping, purification economizer, purification cooler, control rod pressure thimble, control rod drive housing, coolant discharge and vent system expansion tank, coolant discharge and vent system cooler, main condenser and condensate system exhaust piping, hydrogen addition vessel, shield water air blast cooler, decay heat pumps, main and auxiliary steam system piping, deaereator, feedwater heater, evaporator, instrument air dryer, instrument air receiver, and diesel starting air tank. (M.L.S.)

30159 (ORNL-NSIC-34) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-9. (Oak Ridge National Lab., Tenn.). May 1967. Contract W-7405-eng-26. 282p. Dep. CFSTI.

An indexed bibliography on the current literature in nuclear safety is presented. Information is compiled on the following topics: general safety criteria, siting of nuclear facilities, transportation and handling of radioactive materials, aerospace safety, accident analysis, —reactor transients, kinetics, and stability—, —fission product release, transport, and removal—, sources of energy release under accident conditions, —nuclear instrumentation, control, and safety systems—, electrical power systems, containment of nuclear facilities, plant safety features, radiochemical plant safety, radionuclide release and movement in the environment, —environmental surveys, monitoring and radiation exposure of man—, meteorological considerations, operational safety and experience, safety analysis and design reports, and bibliographies. (M.L.S.)

30160 (ORNL-TM-1523) ORIC: A FORTRAN IV CODE FOR COMPUTING OPTIMUM PLANT DESIGNS FOR THE DESALINATION OF SEAWATER AND THE PRODUCTION OF ELECTRICITY. Winsbro, R. B. (Oak Ridge National Lab., Tenn.). Aug. 1966. Contract W-7405-eng-26. 120p. Dep. CFSTI.

A computer program, ORIC (Oak Ridge Integrated Code), has been written for the IBM-7090 for determining that combination of water plant process variables which will result in the minimum total annual cost of an integrated plant complex for the desalination of seawater and the production of electricity using nuclear power. The integrated plant consists of a reactor plant for the production of steam, a turbine-generator plant for the production of electricity, and a multi-stage flash evaporation plant for the production of fresh water. For an assigned combination of water and net electricity production, cost, heat, and mass transfer equations are solved by a systematic method which determines the optimum design parameters for an integrated plant. ORIC gives as output tables which define production capacities, costs, and various design features. (auth)

30161 (ORNL-TM-1789) A SURVEY OF EQUILIBRIUM FUEL-CYCLE COSTS FOR A LOW-ENRICHED, UNCLAD, HELIUM-COOLED UO_2-GRAPHITE REACTOR. Podeweltz, C. M. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 55p. Dep. CFSTI.

A survey of equilibrium, fuel-cycle costs associated with various combinations of lattice pitch, enrichment and fuel-hole size has been carried out for a gas-cooled, unclad, UO_2–graphite reactor. The UO_2 was assumed to be formed into pellets with no coating applied. Nineteen UO_2 holes intermingled with 42 coolant channels comprised a central cluster region in the graphite cell. Enrichment was varied in the range of natural to 5%; lattice pitch in the range of 10.8 to 14.8 in. Two fuel-hole dia, 0.375 and 0.576 in., were investigated. The reactor was assumed to deliver 1900 MW(t) and 760 MW(e). Multigroup, point-depletion calculations of the homogenized cell were performed utilizing GAM self-shielded, resonance cross sections and flux-weighted THERMOS cross sections. For the set of small fuel-hole reactors a minimum fuel-cycle cost of 1.314 mills/kWhr(e) was found. The reactor for which this cost obtained had a conversion ratio of 0.551, and a burnup of 41,083 MWd/t. For the large fuel-hole set the corresponding values were 1.160, 0.637, and 29,400. (auth)

30162 (ORNL-TM-1851) SUMMARY OF THE OBJECTIVES, THE DESIGN, AND A PROGRAM OF DEVELOPMENT OF MOLTEN-SALT BREEDER REACTORS. Briggs, R. B. (Oak Ridge National Lab., Tenn.). June 12, 1967. Contract W-7405-eng-26. 82p. Dep. CFSTI.

Molten-salt thermal breeder reactors are characterized by low specific inventory, moderate breeding gain with low fuel cycle cost, and high efficiency for converting heat into electricity. Studies indicate they should be able to produce electricity in 1000-MW(e) stations for about 2.6 mills/kWhr in investor-owned utilities, a cost that is as low or lower than projected for advanced converter reactors or fast breeder power stations. The fuel utilization characteristics compare favorably with those of fast breeders. The present status of the breeder technology is being demonstrated in successful operation of the Molten-Salt Reactor Experiment. A two-region Molten-Salt Breeder Experiment to demonstrate all the basic technology for full-scale breeders is proposed as the next step in the development. Design and construction of the MSBE would be accompanied by a program of fuels, materials, fuel reprocessing, and engineering development. Development, construction, and startup of the breeder reactor is estimated to take about eight years and to cost about $125 million. (auth)

30163 (ORNL-TM-1853) CHEMICAL RESEARCH AND DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS. Grimes, W. R. (Oak Ridge National Lab., Tenn.). June 6, 1967. Contract W-7405-eng-26. 138p. Dep. CFSTI.

Results of the 15-year program of chemical research and development for molten salt reactors are summarized. These results indicate that $^7LiF-BeF_2-UF_4$ mixtures are feasible fuels for thermal breeder reactors. Such mixtures show satisfactory phase behavior, they are compatible with Hastelloy N and moderator graphite, and they appear to resist radiation and tolerate fission product accumulation. Mixtures of $^7LiF-BeF_2-ThF_4$ similarly appear suitable as blankets for such machines. Several possible secondary coolant mixtures are available; $NaF-NaBF_3$ seem, at present, to be the most likely possibility. Gaps in the technology are discussed along with the accomplishments, and an attempt is made to define the information (and the research and development program) needed before a Molten Salt Thermal Breeder can be operated with confidence. (auth)

30164 (ORNL-TM-1854) MATERIALS DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS. McCoy, H. E. Jr.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 89p. Dep. CFSTI.

The materials development program to ensure the successful construction and operation of a molten-salt breeder reactor is discussed. The proposed reactor is a two-region system utilizing a U-bearing fluoride fuel salt and a Th-bearing fluoride blanket salt. A third lower melting fluoride salt will be used as a coolant for transferring the heat from the fuel and blanket salts to the supercritical steam. The primary structural materials are graphite and modified Hastelloy N. The individual fuel cells will be constructed of graphite tubes. These tubes must withstand neutron doses of the order of 10^{23} neutrons/cm^2 and must have very low permeability to gases (because of ^{135}Xe entrapment) and fused salts. These requirements mean that a graphite that is slightly better than any currently available is required. We have described what graphites are available and their respective properties. Action for obtaining improved grades of graphite is proposed with a test program for evaluating these new products. Modified Hastelloy N will be used in all parts of the system except the reactor core. Since standard Hastelloy N is embrittled at elevated temperatures by neutron irradiation, it has been necessary to modify the composition of the alloy with a small addition of Ti. The program necessary for fully developing this modified alloy as an engineering material is described. An integral part of the proposed system is a joint between the tubular graphite fuel channels and the modified Hastelloy N. Brazing alloys have been developed specifically for this job and a reasonable design for the joint has been made. The integrity of the joint must be demonstrated by engineering tests. (auth)

30165 (ORNL-TM-1855) COMPONENTS AND SYSTEMS DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS. Scott, Dunlap; Grindell, A. G. (Oak Ridge National Lab., Tenn.). June 30, 1967. Contract W-7405-eng-26. 57p. Dep. CFSTI.

A study was made of thermal molten-salt breeder reactors (MSBR) to identify important design and development problems. The purpose of the study was to organize a program to produce components for use in a molten-salt breeder experiment (MSBE). The reference design concept is a two-region, two-fluid system with the fuel salt separated from the blanket salt by graphite tubes. The energy produced in the reactor fluid is transferred to a secondary coolant-salt circuit, which couples the reactor to a supercritical steam cycle. The specific development problems to be studied include the reactor core and heat exchanger hydraulics, pumps for the three salt systems, heat transfer in the heat exchangers and boiler-superheater, mechanical valves for salt flow control, control rod and drive, pressure relief in coolant system, cell insulation and heaters, and the cover gas system. Separate loop designs for the boiler-superheater and for the cover gas system in addition to several small test stands for individual components are included. (auth)

30166 (ORNL-TM-1856) INSTRUMENTATION AND CONTROLS DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS. Tallackson, J. R.; Moore, R. L.; Ditto, S. J. (Oak Ridge National Lab., Tenn.). May 22, 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Instrumentation in use in the MSRE provides a good basis for development of the instrumentation for large molten-salt breeder reactors. The development would involve primarily the testing and improvement of existing instrument components and systems. New or much improved devices are required for measuring flows and pressures of molten salts in the fuel and blanket circulating systems. (auth)

30167 (ORNL-TM-1857) PHYSICS PROGRAM FOR MOLTEN-SALT BREEDER REACTORS. Perry, A. M. (Oak Ridge National Lab., Tenn.). June 12, 1967. Contract W-7405-eng-26. 38p. Dep. CFSTI.

The sources of possible error in estimates of breeding performance of a Molten-Salt Breeder Reactor are discussed. Uncertainties in cross sections may contribute an uncertainty of about ±0.026 in breeding ratio. Other sources of error may arise from assumptions regarding behavior of fission products, or from inadequacies in methods of computation. A reactor physics development program is outlined which should provide a sound basis for design of a reactor experiment. (auth)

30168 (ORNL-TM-1858) SAFETY PROGRAM FOR MOLTEN-SALT BREEDER REACTORS. Kasten, Paul R. (Oak Ridge National Lab., Tenn.). June 9, 1967. Contract W-7405-eng-26. 39p. Dep. CFSTI.

Investigations required in determining the safety characteristics of MSBR power plants are outlined, and associated safety program cost estimates are given. The safety features of the major plant systems in the MSBR are described; the favorable characteristics arise from the prompt negative temperature coefficient of reactivity, the low system pressures, the mobility of fluid fuel, and the low excess reactivity available to the reactor at any time. Reactivity additions which need detailed study include those associated with net fuel addition to the core region, those due to graphite behavior, those caused by changes in fluid flow conditions, and those due to control rod movement. Reactivity coefficients which require evaluation include those associated with temperature, voids, pressure, fuel concentration, and graphite concentration. The integrity of plant containment under reactivity incident conditions and also under circumstances where reactivity itself is not involved need to be evaluated; included here are events such as mixing of water and steam with coolant salt, criticality in regions outside the core, and flow blockage within the fuel or coolant streams. Stability analysis of the reactor plant is required to determine the operating, control, and/or design requirements for obtaining satisfactory plant characteristics. Physical behavior of materials and of equipment under MSBR conditions, as they relate to reactor safety, need to be determined experimentally. In order to delineate and resolve the basic safety problems associated with MSBR systems, it is estimated that about $1.3 million is required over a period of about eight years, with most of the effort ($0.9 million) occurring during the first four years. (auth)

30169 (ORNL-TM-1859) MAINTENANCE DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS. Blumberg, Robert (Oak Ridge National Lab., Tenn.). June 30, 1967. Contract W-7405-eng-26. 17p. Dep. CFSTI.

The maintenance system of the proposed molten-salt breeder reactors will be based upon the technology in use and experience gained from the Molten-Salt Reactor Experiment. The unit replacement scheme, long-handled tools, movable maintenance shields, and the means for handling contaminated equipment will be similar for many operations. The techniques must be improved and extended and new techniques must be developed for maintaining some of the larger more radioactive components of the breeder reactors. Remote welding is needed for major component replacement. Methods must be available for replacing the core and for the repair of heat exchangers. Finally, a general development and design surveillance program will be required. These programs are described and their cost is estimated. (auth)

30170 (SWRI-1228-9-8) THE FIRST INSPECTION OF THE ELK RIVER REACTOR PRESSURE VESSEL AFTER OPERATION. Norris, E. B. (Southwest Research Inst., San Antonio, Tex.). June 10, 1966. Contract AT(11-1)-1228. 31p. Dep. CFSTI.

The Elk River Reactor pressure vessel inspection was carried out after the reactor was operated for approximately one full power year. Inspection procedures are discussed. No cracks were found in the shell nozzle and top head overlays. Cracking found in the shell flange overlay was not deemed serious enough to warrant repair. (auth)

30171 (TID-23816) SENA QUARTERLY REPORT NO. 18, OCTOBER 1–DECEMBER 31, 1966. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Feb. 27, 1967. 17p. (EUR/C-1438/67e). Dep. CFSTI.

Activities related to reactor design and to procurement of prefabricated components are reported. On-site work included reactor loading, restoring reactor operation after outages, and systems testing. (J.R.D.)

30172 (TRG-Report-1432) ADVANCED GAS-COOLED REACTOR SYSTEM. Dent, K. H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). [1967]. 16p. (CONF-660926-6). Dep. CFSTI.

From International Nuclear Industry Fair and Technical Meetings, Basel, Switzerland.

The AGR has brought together two important fields of technology—the technology of gas-cooled reactors, of which Britain has already 6000 MW(e) and 50,000 million kwh of experience, and the technology of modern steam generating plant, which has been brought to its present state of efficiency over many years by the leading industrial countries of the world. The key to this important advance is the unique design of stainless-steel-clad UO_2 fuel; it allows gas temperatures high enough to achieve the standard subcritical or supercritical steam cycles of today, and of the foreseeable future. The economy of AGR power plant has already been demonstrated, under British conditions, in its choice for the 2 × 600 MW(e) station at Dungeness "B." Its simplicity of construction, its modest cooling water requirements, and the siting freedom allowed by the reactor's exceptional safety characteristics, are making it of interest in many areas of the world. (auth)

30173 (UCRL-70258) CENTRAL STATION APPLICATION OF GRAPHITE HELICAL ROTOR EXPANDERS. Wells, W. M. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 28, 1967. Contract W-7405-eng-48. 35p. (CONF-670806-2). Dep. CFSTI.

For Presentation at 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla.

A preliminary examination is made of utilizing graphite helical rotor expanders in central station cycles similar to those proposed for inert gas nuclear MHD cycles. It is indicated that thermodynamic cycle efficiency will be better than for the MHD cycles. Graphite is currently available in the correct size range and with adequate mechanical properties. Gas bearings are indicated to be feasible for the application to central stations. (auth)

30174 (UJV-1753) VYPOCTOVY PROGRAM PRO URCENI NEUTRONOVYCH TOKU, DAVKY A ZDROJU TEPLA VE STINENI JADERNEHO REAKTORU. (Program for Calculation of Neutron Fluxes, Dose Rates, and Neutron Heat Sources in Shielding of Nuclear Reactor). Burian, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1967. 20p. (In Czech). Dep.

A program for neutron flux calculation is given. The program utilizes various forms of multigroup equations to calculate flux as a function of distance through reactor shields. It can also be used to calculate neutron dose rates, heat sources from elastic and inelastic neutron scattering, and coefficients for heat source approximation. The program is written in ALGOL language for the GIER computer. (M.L.S.)

30175 (WAPD-TM-599) IDENTIFICATION OF IMPORTANT FISSION PRODUCT NUCLIDES FOR RADIOLOGICAL DOSE CALCULATIONS FOLLOWING A ^{235}U-FUELED REACTOR ACCIDENT. Connors, D. R.; Litke, H. J.; Rampolla, D. S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1967. Contract AT(11-1)-Gen-14. 123p. Dep. CFSTI.

A set of fission-product data is compiled for all known nuclides believed to be important to the radioactivity of a U-fueled reactor following power operation. Data are presented for 326 nuclides and metastable states and are resolved into a set of 175 linear chains for computation of the inventory of radioactive products. Based upon these data, a calculation is presented of the activity contained in a hypothetical reactor core following extended power operation. The total dose delivered downwind in the event of the release of portions of this inventory to the atmosphere following a reactor accident is calculated for various internal and external organs of a man located at various distances downwind from the point of release. The fraction of the dose to each organ that arises from each nuclide or metastable state is determined for two characteristic downwind locations. A selection is made of the most important nuclides and chains to be used in similar types of downwind dose calculations. Comparisons of the downwind dose obtained from this reduced set of chains and another typical set for representing the inventory of radioactive products are presented. Although the reduced sets of chains are found to yield adequate dose calculations for the conditions considered, it is concluded that the adequacy of these reduced sets cannot be guaranteed for other conditions. (auth)

30176 (WAPD-TM-606) XENON SPATIAL STABILITY IN LARGE SEED-BLANKET REACTORS. England, T. R.; Hartfield, G. L.; Deremer, R. K. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1967. Contract AT(11-1)-Gen-14. 186p. Dep. CFSTI.

A general modal method of analysis for spatial instabilities, which can utilize the multidimensional diffusion programs normally used in reactor design, is developed. The pertinent equations and the methods of their application are discussed and developed with an exposition oriented toward the needs and tools of the nuclear designer. Moderator temperature and fuel temperature (Doppler) feedback effects are included. The methods are practical, and are applicable to any reactor for any nuclide chain. The validity of the analytical methods is documented by: exact one-dimensional studies, comparisons with observed variations in the stability of the Shippingport reactor, and LSBR analog studies in two and three dimensions. The results of extensive LSBR calculations and analog studies are included. The effects of geometrical configuration, power distribution, fuel types and compositions, temperature feedback, higher order transport, and reactor lifetime on stability are examined. Reactor stability for nuclides other than ^{135}Xe is also discussed. It is found in both digital and analog studies that the moderator and Doppler reactivity coefficients are strong stabilizing influences. All studies quantitatively agree. The LSBR designs would be stable to spatial Xe oscillations throughout life primarily because of the Doppler coefficient and yield advantage inherent to the ^{232}Th/^{233}U fuel chain. (auth)

30177 (WAPD-TM-693) ACT-I: A DIGITAL PROGRAM FOR THE ANALYSIS OF THE CONTAINMENT TRANSIENT DURING A LOSS OF COOLANT ACCIDENT IN LWB. Fuls, G. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT-(11-1)-Gen-14. 28p. Dep. CFSTI.

A description of the Act-I computer program for the prediction of the containment transient resulting from the injection of high enthalpy liquid and heat during a loss-of-coolant accident is given. A finite difference integration is performed over the time of the transient accounting for heat and mass additions from input tables, for heat transfer to various heat sinks including simulated safeguards, and for leakage from the container to the atmosphere. The output of the FLASH program has been modified to present the data in a readily usable form as input tables of heat and mass addition to Act-I. Some numerical comparisons with existing data are made. (M.L.S.)

30178 (WCAP-3269-60) REACTOR SAFETY ANALYSIS. Ehrenpreis, S. N.; McAdoo, J. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1966. Contract AT(30-1)-3269. 171p. Dep. CFSTI.

The aspects of reactor system behavior which affect the potential for radiation exposure of persons or contamination of the environment are reported. Reactivity fault protection and mechanical malfunction protection are discussed. The method of analysis of potential zirconium–water reactions is discussed. The quantities of fission product and other radioactive materials subject to release under accident conditions are calculated as a basis for potential radiation dosage. General assumptions for accident analyses are reported. (J.C.W.)

30179 (WCAP-3385-10) SAXTON PLUTONIUM PROGRAM. Semiannual Progress Report for the Period Ending December 31, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). May 1967. Contract AT(30-1)-3385. 40p. (EURAEC-1777). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The physics measurements made during the Saxton shutdown are described. Core burnup and reactivity characteristics were followed and compared with analysis. Results of visual and dimensional analyses performed on each fuel rod are discussed. Fission gas samples, taken from each fuel rod, were analyzed. (M.L.S.)

30180 (WCAP-3696-3) PRESSURIZED WATER REACTOR pH-REACTIVITY EFFECT. Quarterly Progress Report for the Period Ending March 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1967. Contract AT(30-1)-3696. 84p. (EURAEC-1828). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The program for study of the pH-effect on pressurized water reactors is outlined. The instrumented 3 × 3 assembly for the Saxton reactor was redesigned to accommodate two UO_2 fuel rods containing central thermocouples. The calculations to determine UO_2 enrichment are discussed. The results of measurements performed during a pH test at the Enrico Fermi plant in Trino are reported. The results of in-pile hydraulic and thermal tests of the effect of higher average fuel temperature on core coolant exit temperatures after scram are discussed. The results of the reactor trip tests at Saxton are presented in detail. (M.L.S.)

30181 (WCAP-6082) YANKEE CORE EVALUATION PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1966. O'Boyle, M. J. (comp. and ed.) (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1967. Contract AT(30-1)-3017. 147p. Dep. CFSTI.

The results of the chemical evaluations of corrosion products from the Yankee core are presented. The thermal and hydraulic analysis of local boiling in the Phase III fuel assembly of Yankee Core IV is discussed. Preirradiation and postirradiation testing of the Yankee fuel cladding was done at the GE Vallecitos Laboratory; results are given. Comparisons between calculated and measured Pu production in spent fuel are presented. The results of the calculations of ^{241}Pu half-life are given. (M.L.S.)

30182 HOW FUEL MANAGEMENT SPELLS THE DIFFERENCE BETWEEN NUCLEAR SUCCESS AND COSTLY SHUTDOWN. Power, 111: 110-13(June 1967).

The design, acquisition, handling, and disposition of fuel for nuclear power plants are discussed. A plan for fuel management oriented toward annual refueling is outlined. Topics considered include: complete fuel purchase, energy purchase, fuel fabrication purchase, long-term buying, economical reactor operation, burnup records, and replacing failed fuel. (M.C.C.)

30183 REACTOR PRESSURE VESSELS: DESIGN, FABRICATION, AND TESTING. Porse, L. Nucl. Eng., 12: 444-8(June 1967).

Detailed design developments, including the application of fatigue analysis resulting in cumulative usage factors, replacement of weldable back-up seals by hollow metallic O-rings, and temperature equalization of the vessel flanges are discussed. A Wedge Opening Loading test has been developed for monitoring radiation effects. Advantages of replacement of the C-Mn-Mo low alloy material at present in use by a higher strength Ni-Cr-Mo alloy are considered. The fabrication and test procedures are described. (UK)

30184 SETTLEMENT OF THE NUCLEAR POWER PLANT. Fekete, Laszlone. Energ. Atomtech., 20: 204-6(Apr. 1967). (In Hungarian).

The siting of the settlement basin for the 800 mw Hungarian power plant is discussed. The criteria to be used for the selection are presented. The procedures for ensuring that these criteria are met are discussed. The actual construction of the basin is briefly considered. (M.L.S.)

30185 FUEL COSTS AND FUEL REQUIREMENTS FOR A 1000 MWe Na-COOLED FAST BREEDER. INVESTIGATION BY VARIATION OF IMPORTANT REACTOR PARAMETERS. Benndorf, K.; Gupta, D.; Haefele, W.; Heusener, G.; Jansen, P. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirtschaft, 12: 212-15(Apr.1967). (In German).

The reactor parameters such as rod power, fuel pin diameter, and the axial and radial blanket thickness were varied within preset ranges to find the optimum values of these parameters. The pressure drop and the temperature difference in the coolant flow across the reactor core and the thermal and electrical power of the reactor were kept constant during the iteration process so that the capital investment and the operation costs could be assumed to be the same for all the reactor designs. The burnup in the core was also kept constant to avoid excessive computer calculation time. The reactor parameters varied in the fuel cycle costs. The fuel rating influences these costs significantly and implicitly over the rod power and the fuel pin dia. The reference breeder with Na cooling and oxide fuel was designed with plutonium carbide fuel and for ^{235}U start-up. (J.C.W.)

30186 FUEL CYCLE INDUSTRY IN AN EXPANDING NUCLEAR POWER SYSTEM. Gupta, D. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirtschaft, 12: 206-11(Apr. 1967). (In German).

The required capacities for various branches of a nuclear cycle industry have been projected for the period 1970-2000. Seven reactor capacities have been examined. Enriched U requirements for western countries are discussed and the economy of the construction of European installations is outlined. (J.C.W.)

30187 ROLE OF THE GfK EXPERIMENTAL PLANTS IN THE FAST BREEDER PROJECT. Brudermueller, G.; Gallenberger, J.; Kraus, H.-J.; Mueller, W.; Ramdohr, H. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirtschaft, 12: 191-4(Apr. 1967). (In German).

The five experimental facilities, Multi-purpose Research Reactor (MZFR), Superheated Steam Reactor (HDR), Compact Sodium Cooled Nuclear Reactor Facility (KNK), Niederaichbach Nuclear Power Station (KKN) and Reprocessing Facility for Spent Nuclear Fuels (WAK) are part of the German atomic energy program and consist of the fast breeder program. HDR and KNK provide valuable contributions to the development of the fast breeder owing to the development program provided and to the special coolants. For both reactors the subsequent installation of a fast core is being discussed. This concept is largely ready for the HDR in particular. Experience in Na technology and behavior of the superheated-steam cooled fuel elements are necessary prerequisites of the construction of this type of fast reactor. The MZFR will be employed in the long-period irradiation of fuel element specimens with a steam-cooled loop and Na capsule irradiation loop. In the WAK, materials from thermal reactors are to be reprocessed initially. If simultaneous core-blanket reprocessing is assumed for the fast breeder, this results in similar isotope compositions as in the future light water fuel elements. The technology proven for fuel elements from thermal reactors can be employed in this case. A shift of the WAK to breeder fuel is possible in principle. (auth)

30188 NUCLEAR REACTOR FEED PUMPS PROFIT FROM FOSSIL-PLANT EXPERIENCE. Karassik, Igor J.; Valentin, J. E. C.; Bush, A. R. (Worthington Corp., Harrison, N. J.). Power, 111: 116-18(June 1967).

Comparison of the steam plant operations of nuclear power stations to that of fossil-fueled power stations is made. Description of various power plants and characteristics of the associated steam plants are detailed. (M.L.S.)

30189 STUDIES ON BURNOUT. PART 2. COMPARISON BETWEEN BECKER CORRELATION AND SOME ALTERNATIVE LINEAR FORMS. Clerici, G. C. (ARS SpA, Milan. Univ., Milan); Garribba, S.; Sala, R.; Tozzi, A. Energ. Nucl. (Milan), 14: 345-9(June 1967).

The numerical comparisons between the predictions of some linearized forms of Becker's correlations and the original expression, with the experimental data of different laboratories is discussed. The results obtained over 1630 data show that the R.M.S. error is of the same order. The error distribution versus P shows that the dependence on P may be improved, replacing, for instance, the function H_{is} of the linearized forms with a polynomial expression of P, extending in this way the pressure validity range. (auth)

30190 PERFECT SAFETY RECORD IS GOAL IN CONSTRUCTION OF NINE MILE POINT NUCLEAR PLANT. Nelson, C. R. (Stone and Webster Engineering Corp., Boston). Power Eng., 71: 34-7(Mar. 1967).

The safety program being conducted in the construction of the Nine Mile Point nuclear power plant is given. A description of the nuclear power station is given. Commercial operation is scheduled for November 1968. (TSS)

30191 SYNTHESIS OF THREE-DIMENSIONAL FLUX SHAPES USING DISCONTINUOUS SETS OF TRIAL FUNCTIONS. Yasinsky, J. B.; Kaplan, S. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 28: 426-37(June 1967).

The method of flux synthesis is extended in a systematic way to allow the possibility of using different sets of trial functions in different axial zones. The necessary equations are derived in

some detail and numerical examples are presented. The results of these examples are very satisfactory and suggest, therefore, that the synthesis procedure can be made much more useful and powerful by extending it in this way. In a more general context they suggest that the basic notation of deriving discontinuous-type approximation methods from an appropriate variational principle is a valid and very effective idea. (auth)

30192 FAST-REACTOR CALCULATIONAL MODELS. Stacey, Weston M. Jr. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 28: 443-9(June 1967).

Three new models have been developed for fast-reactor physics calculations. These were obtained from the energy-dependent P_1 equations by a modal expansion of the neutron flux. For certain classes of problems, these models provide attractive alternatives and supplements to conventional multigroup finite-difference models, in that considerable reductions in complexity and computational effort are realized. Integral experimental data can be used directly in one of the models, and physical insight can be incorporated into all the models via the choice of expansion modes. Each of the models was applied to calculate the integral properties of fast-reactor critical assemblies. (auth)

30193 THE INFLUENCE OF CHEMICAL BINDING ON MILNE PROBLEM NEUTRON LEAKAGE SPECTRA. Kallfelz, J. M.; Beckurts, K. H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 28: 450-2(June 1967).

A method for the measurement of the leakage spectra scattering kernels for parallel and perpendicular emission is given. A general discussion of various techniques which have been used previously for kernel determination are discussed. (M.L.S.)

30194 NOISE-EQUIVALENT SOURCE IN A ZERO-POWER REACTOR. Saito, Keiichi (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 28: 452-6(June 1967).

The theoretical justification for assuming that delayed neutron effects do not cause frequency-dependent noise sources is presented. The noise spectrum of vector response to a vector source is developed from a one point model assuming single-group delayed neutrons and postulation of a stochastic form of differential equations. The conclusion that the assumption of white noise also includes delayed neutron groups is supported. (M.L.S.)

30195 NOTE ON THE HALF-WIDTH OF THE NEUTRON PULSE OF A PULSED REACTOR. Kistner, G. (EURATOM, Ispra, Italy). Nucl. Sci. Eng., 28: 461(June 1967).

A solution of the kinetic equation for prompt neutron decay for the determination of pulse half-width is given. An expression for approximating half-width by assuming a Gaussian pulse shape is also given. The conclusion is that the approximate form is sufficient for parametric studies. (M.L.S.)

30196 NOISE-EQUIVALENT SOURCE IN NUCLEAR REACTORS. Saito, Keiichi (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 28: 384-96(June 1967).

A noise-equivalent source model is given for reactors. This allows calculations of noise contributions to detector outputs. The model is developed by applying nonequilibrium statistical mechanics to a multiplying medium, use of the relationship between the noise source and the Fourier–Laplace transform of the Boltzmann operator, and application of the fluctuation-dissipation theorem. A discussion on the extension of the method to nonlinear systems is also given. (M.L.S.)

30197 STUDY OF THE KINETICS OF THERMALIZED NEUTRON POPULATIONS IN MULTIPLYING OR NONMULTIPLYING HETEROGENEOUS MEDIA. Deniz, V. (CEN, Saclay, France). Nucl. Sci. Eng., 28: 397-403(June 1967).

A general transport theory formulation of lattice kinetics is obtained for an infinite lattice with a macroscopic spatial flux variation. A study is first made of the variation of the asymptotic inverse period and of the flux distribution as a function of the buckling vector, these being, respectively, the eigenvalue and the eigenfunction of the balance equation for the nonstationary system. Definitions of multiplication factors depends on whether the production operator used is characteristic of instantaneous production rates or production rates in stationary systems. A further arbitrariness in the definition of parameters stems from the freedom of choice of weight functions available. This arbitrariness is characteristic of all parameters that are not eigenvalues. However, with a proper choice of weight functions, the multiplication factors can be made identical to the eigenvalues of static–theory balance equations. These eigenvalues have the unambiguous weaving of being the reciprocals of the factors by which ν is uniformly changed in order to stabilize nonstationary systems. The method is applicable to nonstationary systems around the critical point, and to pulsed systems which may be multiplying or nonmultiplying. An extension to exponential experiments on nondiverging infinite lattices can be very easily obtained. (M.L.S.)

30198 HOW UTILITY SYSTEMS WILL ADD ADVANCED NUCLEAR REACTORS. Nordman, D. A.; Smith, E. E.; Wright, J. H. (Westinghouse Electric Corp., Pittsburgh). Power Eng., 70: 54-7(Dec. 1966).

A computer program to determine the expansion rates of nuclear power plants is presented. High-gain breeders are evaluated for future utility. The economics of adding breeder units is discussed. (TSS)

30199 FUEL ASSEMBLY TTA-1. Waraya, Takashi; Nishijima, Toraji (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 22: 206-10(Feb, 1967). (In Japanese).

A fuel assembly named TTA-1 for JPDR has been fabricated. Various techniques of fabrication and inspection were established, such as casting of stainless steel, flow channel of Zircaloy-2, measurement of gaseous impurities in UO_2 pellets, autoclave treatment for received tubes, ultrasonic inspection, x-ray test, and burst test for weld parts. TTA-2 and TTA-3 are being designed and fabricated, the latter to be irradiated at JPDR. (NSA of Japan)

30200 THE MEASUREMENT OF THOR TRANSFER FUNCTION BY THE METHOD OF REACTOR NOISE ANALYSIS. Ko, Y. C.; Ma, Pu-yuan; Chien, J. P. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 5: No. 1-2, 1-8(Dec. 1966).

The transfer function of THOR has been measured by the method of reactor noise analysis. A TMC 400-channel analyzer was used as a multi-scaler for this measurement. A slow chart recorder was also used for the measurement of the low frequency part of the transfer function as a check. The results were consistent. The lower corner frequency of the transfer function was determined to be 0.014 cps from this experiment. However, the higher corner frequency was not very clear due to the uncorrelated noise at high frequencies. (auth)

30201 A NEW METHOD FOR NONLINEAR REACTOR DYNAMICS PROBLEMS. Canosa, Jose (General Electric Co., Pleasanton, Calif.). Nukleonik, 9: 289-95(Apr. 1967).

Nonlinear problems in the field of reactor excursions are solved analytically with mathematical techniques not used before in reactor dynamics. It is shown that the nonlinear differential equations describing excursion behavior are of a type known as singular perturbation equations. The results obtained from the analytical solutions are in excellent agreement with machine computed results. (auth)

30202 DETERMINATION OF THE EFFECTIVE MULTIPLICATION COEFFICIENT OF NEUTRONS BY THE MEASUREMENT OF THE DIFFERENTIAL REACTIVITY. Dideikin, T. S.; Shishin, B. P. At. Energ. (USSR), 22: 113-17(Feb. 1967). (In Russian).

Relations between the effective multiplication coefficients of neutrons in reactors and the experimental values of reactivity coefficients, determined by measurements of differential reactivities, were established. Correction terms were determined in integral form. (tr-auth)

30203 DEVELOPMENT OF A FUEL ELEMENT FOR A SODIUM COOLED FAST BREEDER REACTOR. Morgenstern, F. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Kerntechnik, 9: 122-5(Mar.-Apr. 1967). (In German).

The fuel-element development is being concentrated on two main points, namely a representative irradiation-test and out-of-pile experiments with prototype fuel-elements. The main problems of the fuel-rod design can be reduced essentially to the assessment of swelling behavior and the behavior of the canning materials embrittled at high temperature, which can be tested only under irradiation environment whereas tests with respect to the behavior of the whole assembly can be performed out of pile. Therefore, a Na test-loop is being prepared. (auth)

30204 SIMPLE SCHEME FOR CALCULATING THE PROMPT EXCURSION OF AN INHERENTLY SAFE REACTOR. Sellerio, Antonio; Spitale, Maria Concetta (Univ., Palermo, Italy). Ing. Nucl., 7: 78-89(Mar.-Apr. 1966). (In Italian).

The prompt excursion of an inherently safe homogeneous reactor is considered. It is shown how to get easy approximate values first making calculations on the basis of a simple scheme and afterwards making the changes which appear absolutely necessary in the results. (auth)

30205 PLUTONIUM IN THE NUCLEAR REACTOR. PART IV. FUEL ELEMENTS. Bucci, Pompeo (CAMEN, Pisa, Italy). Ing. Nucl., 7: 90-6(Mar.-Apr. 1966). (In Italian).

The use of Pu in fuel elements either in metallic alloys or in oxide systems is reviewed. The characteristics of Pu–Al alloys and the oxide fuels used in the Rapsodie, PRTR, and EBWR are tabulated. (J.S.R.)

30206 FAST BREEDER REACTORS COOLED BY SODIUM AND STEAM. Engelmann, P. (Kernforschungszentrum,

Karlsruhe, Ger.). Kerntechnik, 9: 111-17(Mar.-Apr. 1967). (In German).

Fast reactors supplement the light-water reactors to utilize more economically the nuclear fuel resources. In Karlsruhe, the Fast Breeder Project group have been working since 1960 on the development of both Na- and gas-cooled fast power reactors. Detailed design, studies for a 1000-Mw Na-cooled fast breeder, (Na-1) and an equivalent steam-cooled fast breeder, (D-1) have recently been completed. These studies are used to compare the two systems. Results show that Na- and steam-cooled breeders are complementary. The fast zero-energy assembly SNEAK will contribute to the development work. (auth)

30207 THERMAL BREEDER AND ITS PROSPECTS FOR ENERGY PRODUCTION. Steinert, C. (Siemens-Schuckert-werke AG, Erlangen, Ger.). Kerntechnik, 9: 118-21(Mar.-Apr. 1967). (In German).

With regard to an improvement of the utilization of nuclear resources, the development and the early application of advanced converters and thermal breeders is an important task. These reactors require a small amount of development work if they are based on the well known and proved technology of water reactors. The heavy-water moderated Th reactor is appropriate for the Th–U cycle. It was found that the heavy-water moderated and cooled Th reactor with a uniform lattice can contribute significantly to the conservation of nuclear fuel resources, under economic conditions, even without reprocessing. (auth)

30208 CLADDING DEVELOPMENT FOR FAST BREEDER REACTORS. Laue, H. J. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Kerntechnik, 9: 125-8(Mar.-Apr. 1967). (In German).

The cladding development program for the Karlsruhe Fast Breeder Project is given. The requirements which must be met by the material are given by the parameters fixed in the design studies; the selection of the materials is determined by the physical, mechanical and chemical properties of the metals and alloys. The result is that the best claddings are stainless steels for Na-cooled breeders and Ni-base alloys for steam cooled breeders. The study of the irradiation behavior of the alloys, the highest significance being attributed to the high-temperature embrittlement by (n,α) reactions. (auth)

30209 TECHNICAL AND ECONOMICAL OPTIMIZATION OF A URANIUM OXIDE RADIAL BLANKET FOR A 1000 MW SODIUM COOLED FAST REACTOR. Egleme, M.; Michel, A. (Belgo-Nucleaire, Brussels). Kerntechnik, 9: 129-31(Mar.-Apr. 1967).

An optimization study of the radial blanket of a Na cooled fast reactor was carried out on the basis of the German 1000-MW project. With the help of two computer codes, hydraulic, thermal and physic performances were considered and the optimum choice was selected on the basis of the best economics. Results show that large rods (above 1.6 cm) with short lifetime and high fuel volumetric fraction in the blanket seem the best choice in the considered economic context. (auth)

30210 DEVELOPMENTAL INVESTIGATION ON DRIVING MECHANISM FOR CONTROL RODS OF BOILING-WATER TYPE POWER REACTOR. Fujisaki, Yukio; Masuda, Takahisa (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 21: 1278-83(Dec. 1966). (In Japanese).

Trial manufacture and tests have been made with success on two types of hydraulic driving mechanisms for control rods of BWR type power reactors. Performance tests were conducted on shims and scrams under different conditions—under normal pressure at normal temperature, and under high pressure and temperature of up to 74 kg/cm^2 and 289°C; and endurance tests were made through scrams repeated 2,000 times. Sufficient data have been obtained for design and manufacture of practical control mechanisms of this kind. (NSA of Japan)

30211 OUTLINE OF AGR-J JOINT STUDY BETWEEN UKAEA AND FAPIG. Anahara, Ryoji (Fuji Electric Mfg. Co., Ltd., Japan). Fuji Jiho, 40: 158-64(Feb. 1967). (In Japanese).

The design and estimated generating costs of an advanced gas cooled reactor for Japan is given. Reactor sizes examined were 300 and 600 MW, referred to as AGRJ-300 and AGRJ-600, respectively. (NSA of Japan)

30212 MEASUREMENT OF STEAM VOID FRACTION IN JPDR. Yusa, Hideo (Hitachi Ltd., Tokyo); Uga, Takeo. Hitachi Hyoron, 48: No. 11, 1-6(Nov. 1966). (In Japanese).

Void fractions in JPDR were measured using a void-meter. The void meter has high sensitivity, and withstands severe in-core conditions including high temperature, pressure, and radiation levels. The void distribution was established at the upper part of the chimney and the down-comer entrance. The digital void-meter and the results of measurements are described. The outer dia of the void meter detecting part should be as small as possible in comparison with the steam-bubble dia, and its electrode approach the form of a point. In the digital void meter, the void fraction can be obtained by averaging timewise the large number of pulse signal areas, obtained when the electrode traverses the bubbles by means of an integrating circuit. The void fraction at the chimney outlet should be nearly proportional to the in-core thermal neutron flux, and the fraction in the middle smaller than in the circumferential region in the JPDR where the control rods are drawn up. The void fraction at the down-comer entrance is increased as the reactor water-level is lowered. (NSA of Japan)

30213 CLASSIFICATION OF THE LEADING LINES AND THEIR NATURE IN THE ENGINEERING OF CONSTRUCTION OF AN ATOMIC POWER PLANT. Shimizu, Yasukazu; Ishida, Hideki (Fuji Electric Mfg. Co., Ltd., Japan). Nippon Kenchiku Gakkai Ronbun Hokoku-Shu, Special Edition, 571(Oct. 1966). (In Japanese).

Atomic power plants employ varieties of instruments and equipment. These items are connected together by means of pipes, ducts, cables and transport media. The classification, nature and degree of requirement of such networks are considered in comparison with those in the similar conventional structures. The network planning in atomic power plants is described. (NSA of Japan)

30214 LEADING LINES PLANNING IN THE ENGINEERING OF CONSTRUCTION OF AN ATOMIC POWER PLANT. Shimizu, Yasukazu; Ishida, Hideki (Fuji Electric Mfg. Co., Ltd., Japan). Nippon Kenchiku Gakkai Ronbun Hobaku-Shu, Special Edition, 572(Oct, 1966). (In Japanese).

The various networks (including cables, ducts, etc.) in atomic power plants can be divided into several groups, according to the severity of requirements. The distribution planning for the network is dependent on equipment and instruments. A description is given of techniques of such distribution, including the minimization in the lengths of lines, the centralization and grouping of lines, design of vertical shafts, and design of horizontal routes. These factors are important in cost estimation of atomic power plants. (NSA of Japan)

30215 REACTOR MATERIALS. Volume 10, Number 1. Simons, E. M.; Porembka, S. W. Jr.; Keller, D. L. (eds.). A Quarterly Technical Progress Review published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Spring 1967. 67p. GPO $0.70 Domestic, $0.90 Foreign.

Separate abstracts were prepared for the 5 sections comprising the review. (J.C.W.)

For abstracts of individual sections see: 30216 and 30303–30306.

30216 FUEL AND FERTILE MATERIALS. Reactor Mater., 10: 1-19(Spring 1967).

A review of recent research development in fuel and fertile reactor materials is presented. (94 references). (J.C.W.)

30217 IMPROVEMENTS RELATING TO PULSED NUCLEAR REACTORS. Kistner, Gustav; Meister, Herbert; Raievski, Victor (to EURATOM). British Patent 1,071,443. June 7, 1967. Priority date Aug. 15, 1963, Germany.

A design for a pulsed reactor is given in which a pulsed neutron source is located in the reflector. The pulse is controlled by means of a window which has two moving screens. The screens are made of reactivity increasing materials and can be overlapped. (M.L.S.)

30218 NEUTRON SOURCE FORMING A PULSED FAST REACTOR. (to EURATOM). British Patent 1,071,442. June 7, 1967. Priority date Aug. 15, 1963, Germany.

A design for a pulsed fast reactor is given in which a neutron source is located in the reflector. The pulse is controlled by means of windows which have two synchronized moving screens. The screens are made of reactivity increasing material. (M.L.S.)

30219 REACTOR CONTROL ROD. Hiratsuka, Yasumasa (to Hitachi Ltd.). Japanese Patent 1966-11439. May 27, 1966. Filed Feb. 8, 1963.

A design for a control rod which moves among the fuel elements and is supported by the lattice plates, in the direction of the axis of the fuel elements, is given. Rod-shaped control elements are piled up horizontally within the plate one over the other. (NSA of Japan)

30220 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 1,070,835. June 7, 1967. Priority date Oct. 31, 1963, United States.

A design is given for a high temperature reactor with a reflector surrounding the core; the reactor is capable of operating at dif-

ferent temperatures in different regions of the core. A neutron absorber is dispersed throughout the core to provide reactivity control. Various specifications for absorber materials are given. (M.L.S.)

30221 NUCLEAR REACTOR CONTROL MECHANISM. Tyrrell, Owen Alexander; Adshead, Harry; Tattersall, John Owen (to United Kingdom Atomic Energy Authority). British Patent 1,070,572. June 1, 1967. Filed May 29, 1963.

A reactor control mechanism having a fluid-operated piston and a cylinder device to move the control unit is described. (J.C.W.)

30222 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR PLANTS. (to Babcock and Wilcox Co.). British Patent 1,070,766. June 1, 1967. Priority date June 26, 1964, United States.

Design and operation of a reactor is described in which the fuel elements are placed in solid moderator material. Provision is included for heat transfer from the fuel elements and moderator to the generator using a fluid. (J.R.D.)

30223 SUPPORTING SYSTEM FOR THE SKIRT SUPPORTING A NUCLEAR REACTOR. Rachais, Claude Georges (to Electricite de France). British Patent 1,070,507. June 1, 1967. Priority date July 21, 1964, France.

A structure design for supporting the core of a nuclear reactor is given. (J.C.W.)

30224 NUCLEAR REACTOR. Hutchinson, William George; Cole, Leslie Charles; Riley, Peter Liptrot (to United Kingdom Atomic Energy Authority). British Patent 1,070,571. June 1, 1967. Filed Mar. 22, 1963.

A reactor is described comprising a cylindrical reactor vessel, fuel element supports within the vessel to define a core zone eccentric with respect to the vessel, and a storage zone alongside the core zone. The design includes an outer rotary shield concentric with respect to the vessel for closing the vessel upper opening. A transfer mechanism is carried eccentrically by the inner shield which is movable over these zones by rotation of the inner and outer shields, and a control face is provided from which to suspend reactivity control mechanisms. (J.R.D.)

30225 IMPROVEMENTS IN NUCLEAR REACTORS. Peters, Martin Charles; Harris, Herbert; Band, Michael Henry Whewell (to Babcock and Wilcox Ltd.). British Patent 1,070,285. June 1, 1967. Filed June 3, 1964.

A liquid-cooled and -moderated nuclear reactor with a single pressure vessel housing the core and the heat exchangers is described. (J.C.W.)

30226 NUCLEAR ENERGY AND SAFETY. Proceedings of the Foratom–FIEN International Study Days, Rome, June 18–19, 1964. Rome, Forum Italiano dell'Energia Nucleare, 1964. 119p. (CONF-640633).

An overall concept of nuclear safety and its effects are considered. The general aspects of nuclear safety and the definitions and limitations of risks incurred in nuclear activities are discussed. The juridical, legislative, and financial means for meeting possible risks are examined. The influence and importance of public opinion on the handling of possible accidents is detailed. The role of public information in the field of reactor safety is considered. (M.L.S.)

30227 SKIRT FOR SUPPORTING A REACTOR. Ukaji, Hideo (to Hitachi Ltd.). Japanese Patent 1966-11679. May 31, 1966. Filed Aug. 27, 1963.

A design is given for a cylindrical support-skirt which is installed on the upper part of a high-temperature reactor pressure-vessel with the upper edge being fixed to the concrete shield; the space over the pressure-vessel, within the skirt and above, is filled with shielding water. Within the skirt, in the shielding water, at least two annular plates are placed horizontally surrounding the spherical part of the pressure vessel. These annular plates are located with some space between the plate and the skirt and between the plate and the vessel. (NSA of Japan)

30228 IMPROVEMENTS IN PUMPING. (to General Electric Co.). British Patent 1,071,279. June 7, 1967. Priority date Apr. 5, 1965, United States.

A design is given for a reactor which utilizes a unique method for coolant circulation. The cooling system includes a jet pump and nozzle combination for more efficient circulation. This system is contained within the pressure vessel. (M.L.S.)

30229 NUCLEAR POWER PLANT. Hayashi, Tsutomu (to Hitachi Ltd.). Japanese Patent 1966-11440. May 27, 1966. Filed May 9, 1963.

The design for a reactor core consisting of fast and thermal regions is given, the fast region cooled by steam, placed in a few containers, is distributed appropriately within the thermal region. In the steam circulating circuit there exist, connected in series, the following: the reactor core, the turbine, the feedwater pump, the heat-exchangers in which coolant from the thermal region is used as the heating medium, and the heat-exchangers in which coolant from the fast region is used as the heating medium. Coolant is circulated through this circuit and into one of the fast-region containers; steam from this container is led to the turbine. (NSA of Japan)

30230 FAST REACTORS. London, British Nuclear Forum, 1967. 63p.

The development of the fast reactor in UK is discussed indicating some of the technical problems involved, and explaining how they have been overcome. The emphasis is on the sodium-cooled reactor, and on design of the 250 MW(e) reactor, under construction at Dounreay. Subjects covered include power plant, reactor vessel, reactor core, primary heat exchangers, steam generators, pumps, valves, control rods, fuel handling, instrumentation, generating plant, fuel services, inspection and safety. (UK)

30231 SPETSIAL'NYE GIDROTEKHNICHESKIE SOORUZHENIYA NA ATOMNYKH PREDPRIYATIYAKH. (Special Hydrotechnical Constructions for Nuclear Installations). Kuzovlev, G. M. Moscow, Atomizdat, 1966. 284p.

In connection with the construction of heavy-duty energy systems fed by nuclear fuels, great attention was given to questions of reactor construction and safety techniques. Data on the construction design for storage and transportation of liquid radioactive materials in nuclear installations were given. The basic physical–chemical processes affecting the motion of impurities were described in connection with the migration of radioactive isotopes. (tr-auth)

30232 FIZICHESKIE ISSLEDOVANIYA ZASHCHITY REAKTOROV. (Physical Research into Reactor Safety). Kazanskii, Yu. A.; Kukhtevich, V. I.; Matusevich, E. S.; Sinitsyn, B. I.; Tsypin, S. G. Moscow, Atomizdat, 1966. 392p.

The detailed characteristics of the complete radiation spectrum within and at the boundary of biological shields are examined. The empirical data necessary for design of reactor shields are analyzed and generalized. The spatial, energy, and angular distributions of γ radiation and neutrons in the shield, the formation and methods for the attenuation of captured γ radiation, and the scattering of γ quanta and neutrons in air and by the shield are examined. The experimental and calculated data are compared. The devices and installations available for the investigation of the shield are described and methods for the obtention of experimental data are reported. (tr-auth)

Marine and Portable Power Reactors

30233 (ORNL-TM-1783) PREIRRADIATION DATA FOR THE FUEL SPECIMENS FOR THE ARMY PM FUEL EXPERIMENT IN THE ORR PRESSURIZED-WATER LOOP. Haynes, V. O.; Richt, A. E. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 137p. Dep. CFSTI.

The preirradiation condition of fuel specimens for the Army PM (Portable-Medium) Reactor fuel experiment in the Oak Ridge Research Reactor pressurized-water loop is described. Various instruments and equipment used to perform the measurements and the analytical techniques are also described. Complete information is given for the specimens irradiated for an extended time and, where available, for other specimens fabricated for the fuel irradiation phase of the Army PM advanced-fuel development program. (auth)

30234 (ORNL-TM-1845) TEMPERATURE OF N.S. SAVANNAH IRRADIATED FUEL FOLLOWING A POSTULATED LOSS OF COOLANT FROM THE TRANSFER CASK. Klepper, O. H. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 21p. Dep. CFSTI.

An estimate of the temperature of N.S. SAVANNAH spent fuel following a postulated loss of coolant from the spent fuel transfer cask was made. Hand and digital computer calculations were employed to determine the cask temperature distribution as a function of time after reactor shutdown. Peak cladding temperatures were estimated to remain well below the melting point. (auth)

Rocket and Space Reactors

Refer also to abstracts 28138, 28172, 28173, 29079, and 30090.

30235 (LA-DC-8174) DIGITAL COMPUTER SIMULATION OF FLUID FLOW AND HEAT TRANSFER IN NUCLEAR

PROPULSION REACTORS. McClary, John A.; Murray, Suzanne T. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 21p. (CONF-670706-1). Dep. CFSTI.

From 3rd Propulsion Joint Specialist Conference, Washington, D. C.

A characteristic family of engineering problems is described by conduction, convection, and/or radiation from solid materials. Such problems are basic in designing and analyzing heat exchangers in general and nuclear reactors of the solid core heat exchangers in particular. A method of solution with general applications has evolved during the development of nuclear rocket propulsion reactors. The method provides accurate detailed calculations of fluid temperature, pressure, flow, and solid material temperature distributions in a variety of flow passage configurations and solid geometries with real state and transport properties of the materials. The method of solution has been programmed for digital computers (FORTRAN IV for IBM 7094 and CDC 6600) with the code name OPTION. A new version of the code was recently programmed and satisfies its objectives more completely than the previous version. The new code is described. (auth)

30236 (NAA-SR-Memo-8201) REFLECTOR AND CONTROL DRUM TEMPERATURES DURING STARTUP OF SNAP 2. Dufoe, G. E. (Atomics International, Canoga Park, Calif.). Feb. 14, 1963. 17p. Dep. CFSTI.

Transient temperatures in the reflector and the control drums of SNAP-2 are given. The temperature response of the reflector is slow compared with the reactor-vessel temperature transient. Therefore, the maximum temperature difference between the reflector and the vessel occurs when the vessel first reaches the operating temperature. The steady-state temperature of the reflector and control drums are given. The effects of uncoated shims are to raise the steady-state temperature of the reflector, to raise the reflector-control drum temperature difference, and to raise the maximum orbital pre-startup temperature of the reflector. The effect of increased reactor power and NaK temperature level on the reflector temperature is shown. (auth)

30237 (NAA-SR-Memo-12347) COMPARISON OF BERYLLIUM PHOTONEUTRON DECAY SETS USING EXPERIMENTAL SNAP REACTOR DATA. Ottewitte, E. H. (Atomics International, Canoga Park, Calif.). Feb. 22, 1967. Contract AT(11-1)-Gen-8. 6p. Dep. CFSTI.

The Rotter core set was found to be particularly advantageous over the conventionally used Keepin set by tests using SNAP reactor data. (auth)

30238 (NASA-TN-D-3942) IMPROVING PERFORMANCE OF FACE CONTACT SEAL IN LIQUID SODIUM (400° TO 1000°F) BY INCORPORATION OF SPIRAL-GROOVE GEOMETRY. Ludwig, Lawrence P.; Strom, Thomas N.; Allen, Gordon P.; Johnson, Robert L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 39p. CFSTI.

Conventional face contact seal performance was improved by incorporation of a spiral-groove geometry. Both conventional face contact seals and seals with spiral grooves were used to seal liquid sodium at a pressure of 20 pounds per square inch gage (13.8 N/cm^2 gage) and a sliding velocity of 79 feet per second (24 m/sec). In comparison with conventional face contact seals, seals with spiral grooves had negligible leakage. The wear and contact patterns indicated that the spiral-groove seal operated with separation of the sealing surfaces, which is necessary for long life. Successful low-leakage operation was not achieved with conventional face contact seals having carbide seal seats and nosepieces (hard on hard). Thermal and pressure distortions caused edge contact, wear, and scoring. Conventional face contact seals having seal seats and nosepieces with wear-in properties (soft on hard) showed more leakage than those with carbide sealing surfaces. (auth)

30239 (NP-16767) LITHIUM-BOILING POTASSIUM TEST LOOP. Interim Report. Kikin, Gerald M.; Davis, Jerry P.; Griffin, Daniel C.; Peelgren, Maurice L.; Phillips, Wayne M. (Jet Propulsion Lab., Pasadena, Calif.). Sept. 15, 1966. Contract NAS7-100. 70p. (TR-32-1083).

The construction, instrumentation, and initial phases of operation of the Li–boiling K test loop, designed to investigate overall transient and steady-state characteristics, start-up, control, and stability, of a two-loop, alkali metal, Rankine cycle system for use in spacecraft nuclear–electric propulsion, are described. The loop, constructed of Nb–1% Zr, operates at 30-kW heat input and temperatures up to 2100°F. The primary loop heat source, which is by electric current resistance heat generation in a section of the tube wall, may be programmed to nuclear reactor kinetic equations for simulation of power response to various system perturbations. The secondary loop includes a refractory-metal, single-wheel, reentry-type turboalternator operating at 12,000 rpm. The system has been operated at full power and temperature. Several modes of boiling instabilities were noted during start-up; full-power, steady-state boiling was stable. The first phase of operations was terminated by a power failure which caused extreme K flow oscillations that resulted in damage to the K preheater. This component has been repaired and the system brought back to operation. (auth)

30240 (WANL-TME-1466) SECOND STATUS REPORT SHIELDING STANDARD DESIGN METHOD. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Mar. 1, 1967. Contract SNP-1. 91p. Dep. CFSTI.

The Shielding Standard Design Method is employed by WANL to perform NERVA radiation and shield analyses and design. This method, designated Shielding Standard Design Method II (SSDM-II), is the second generation of methods which has evolved from evaluating comparisons of calculated versus experimental radiation environment data. SSDM II employs three widely used analytical techniques; Monte Carlo, S_n transport, and point kernel. Monte Carlo Program 18-0 is specifically used to calculate gamma ray heating within the pressure vessel. The two dimensional S_n transport code, TDC, generate neutron fluxes by group in an r,z geometry. Point kernel Program 14-0 is used to compute external radiation environment. Many subsidiary linked programs are also employed to generate input data and process output data. Extensive comparisons of SSDM II calculated data with NRX experimental data and other applicable experimental data are presented. The experimental data include internal and external reactor gamma ray dose rates, external fast neutron (E > 2.9 MeV) and thermal neutron environment, and liquid H_2 propellant heating data. A continuous effort is in progress to improve and to more fully automate the SSDM II System. These improvements, which are described in detail include: (1) replacing the TDC transport code with the DDK two dimensional transport code for more accurate calculation of neutron fluxes, and (2) replacing the 14-0 point kernel code with the WANL KAP point kernel code. Two unique neutron-photon S_n transport code system (for one and two dimensional analysis) are being developed. Application of the S_n transport to photon transport analysis is expected to facilitate radiation analysis of reactor-shield systems. (auth)

30241 THERMIONIC NUCLEAR REACTOR ENERGY SUPPLY INSTALLATION FOR A POWER RANGE FROM 5 TO 50 kW(e). Budnick, D.; Janner, K.; Jung, W.; Oldekop, W.; Peehs, M. (Siemens-Schuckertwerke AG, Erlangen, Ger.). pp 235-48 of Energieversorgung im Weltraum. Wurstborn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

Studies were carried out on three types of reactor installations with thermionic energy conversion: fast reactors with thermionic converters in the reactor core, thermal reactors with thermionic converters in the reactor core, and reactor installation with thermionic converters outside the reactor core. The design of the thermionic converter element is described in some detail. For the critical assemblies complete and partial thermionic reactors are described. In the partial thermionic reactor the reactor core consists of a subcritical funnel of thermionic fuel elements surrounded by a neutron multiplying mantle zone. (J.S.R.)

Process Heat and Desalination Reactors

30242 (ORNL-TM-1399) SPECULATIVE ANALYSIS OF THE COST RELATIONSHIP BETWEEN DESALINATION SYSTEM SIZE AND THE MARKET GROWTH RATE. Burwell, C. C.; Ebel, R. A. (Oak Ridge National Lab., Tenn.). Jan. 26, 1966. Contract W-7405-eng-26. 9p. (CF-65-7-49). Dep. CFSTI.

An analytical expression is developed which relates the present worth of a water system to the plant size, life, cost of money, cost-versus-size scaling factor, and market growth rate. The expression is used to develop a set of parametric curves relating system worth to the size of the plant. Subject to the restrictions implied by the assumptions used in the analysis, a plant size of about five times the annual market growth rate produces a "practical" minimum system worth for relatively large variations of interest rate, market growth rate, and cost-versus-size scaling factor. (auth)

30243 (ORNL-TM-1563) INVESTIGATION OF THE ECONOMICS OF REGENERATIVE FEEDWATER HEATING IN DUAL-PURPOSE NUCLEAR DESALINATION PLANTS. Moyers, J. C. (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The effects of various degrees of regenerative feedwater heating in the turbine cycle of a dual-purpose desalination plant using 650 psia saturated prime steam were investigated. Capital and operating cost variations were estimated and the resulting variations of process heat cost to the evaporator plant were determined. The optimum final feedwater temperature was found to decrease with decreasing prime steam cost and increasing fixed charge rate, but for this prime steam condition the use of at least two stages of feedwater heating appears advantageous. (auth)

30244 APPARATUS AND METHOD FOR THE TREATMENT OF BITUMINOUS MATERIALS OR HYDROCARBONS UNDERGROUND WITH HEAT AND NUCLEAR RADIATION FROM NUCLEAR FISSION. (to Deutsche Erdoel-Aktiengesellschaft). British Patent 1,071,059. June 7, 1967. Priority date Sept. 14, 1963, Germany.

The reactor system to provide heat and radiation for underground processing of bituminous materials or hydrocarbons is described. The reactor is fueled with spheres of self limiting reactivity, i.e., expansion causes separation and loss in reactivity. Means are provided for increasing the radiation field by including radioisotopes or fissile material in the circulating liquid moderator. (R.E.U.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 28137, 28193, 28296, 29334, 29831, 29832, 29837, and 30164.

30245 (AECL-2593) DETERMINATION OF LATTICE PARAMETERS USING A FEW RODS. Okazaki, A.; Craig, D. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1967. 83p. Dep. CFSTI. CAN $2.00.

A study has been made to determine whether lattice parameters of natural U, heavy water-moderated lattices can be obtained using as few as seven test fuel rods placed at the center of a driver or reference lattice of known properties. Up to seven test rods were substituted successively for reference rods and the critical height changes measured. Measurements were made for fuel clusters of natural UO_2 and U metal with D_2O, He and organic (HB-40) coolants, in 18 and 22 cm triangular pitch lattices. A two-group heterogeneous reactor calculation program (MICRETE) was used to determine the bucklings of the test rod lattices from the critical height changes. For D_2O-cooled rods the values are in good agreement with those obtained by conventional flux mapping in lattices containing a large number of test rods, even for buckling differences of 6 m^{-2} between test and reference lattices. The agreement is worse for He and HB-40 cooled rods. Measurements were made of the neutron flux distribution, Westcott spectrum parameters r and T, initial conversion ratio, and fast fission ratio using seven test rods and in general the results are in agreement with those made in lattices containing a large number of rods. (auth)

30246 (AECL-2667) CANDU-BLW EXPERIMENTS IN ZED-2. PART I. REFUELLING EXPERIMENT. Kay, R. E.; Tanner, C. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 40p. Dep. CFSTI. CAN $1.50.

Experiments were performed in a simulated CANDU-BLW lattice in ZED-2 to determine the reactivity effect and the perturbing effect on the surrounding lattice of replacing the fuel in the central cell of the lattice by light water. This procedure simulates two stages in the refueling sequence of the proposed CANDU-BLW reactor. The maximum neutron density perturbation observed in surrounding fuel assemblies was a depression ~16% at the assemblies immediately adjacent to the perturbation. (auth)

30247 (AERE-R-5347) THE DETERMINATION OF THE FAST-NEUTRON SPECTRUM IN POSITIONS IN THE DAPHNE REFLECTOR. Silk, M. G. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 30p. Dep. CFSTI. UK 4s. 6d.

The difficulties inherent in spectrum determinations in reactors at positions remote from the core center are considered, and the suitability of ^6Li and ^3He semiconductor sandwich spectrometers for this work is discussed. Spectra obtained in many positions in the DAPHNE reflector are compared with calculated spectra. (auth)

30248 (AMRA-TR-67-05) BERYLLIUM-FILTERED NEUTRON BEAM QUALITY FROM THE AMRR AS EFFECTED BY CORE ELEMENT ARRANGEMENTS. Antal, John J.; Warnas, Albert A. (Army Materials Research Agency, Watertown Arsenal, Mass.). Feb. 1967. 19p.

Neutron spectra in the region of 4 to 8 Angstroms have been obtained for various fuel and BeO reflector arrangements in the Army Materials Research Reactor. Intensity and signal-to-noise ratio changes in the range of 15 to 20% have been obtained at a single axis crystal spectrometer through rearrangement of core elements immediately adjacent to the beam tube termination. In general, the results indicate that the experiment external to the reactor should view reflector element material only, at the core face, and this reflector material should be surrounded by fuel for the best intensity and signal-to-noise combination. Spectral shift changes were found to be less than 4%. Some data on the removal of water from beam tube gaps are included. (auth)

30249 (ANL-7203) HIGH CONVERSION CRITICAL EXPERIMENTS. Boynton, A. R.; Baird, Q. L.; Plumlee, K. E.; Redman, W. C.; Robinson, W. R.; Stanford, G. S. (Argonne National Lab., Ill.). Jan. 1967. Contract W-31-109-eng-38. 81p. Dep. CFSTI.

A program of critical experiments has extended the range of measured nuclear parameters of light-water-moderated, slightly enriched, UO_2 lattices further into the undermoderated region. The H-to-^{235}U atom ratios in the cores assembled ranged from about 5 to 0.5. The initial conversion ratio, ^{238}U-to-^{235}U fission ratio, ^{238}U capture Cd ratio, thermal disadvantage factor, and Cd ratios of various materials reported were measured in the full range of lattices; the bucklings, critical masses, and reflector savings reported were measured in the looser assemblies. Information on temperature coefficient and control-element and various material worths is included. Although the experimental results are not compared with calculations, these results are correlated with results obtained at other laboratories with similar fuel at higher H-to-^{235}U ratios. (auth)

30250 (BNL-11353) COMPARATIVE ANALYSIS OF SOME GRAPHITE AND WATER MODERATED REACTOR LATTICES. Hellens, R. L.; Sehgal, B. R.; Mizuta, H. (Brookhaven National Lab., Upton, N. Y.). [1967]. 11p. (CONF-670607-2). Dep. CFSTI.

From International Conference on Physics Problems of Thermal Reactor Design, London, England.

A theoretical study was made of the graphite moderated BICEP experiments and of some recent BNL water moderated exponential experiments by a combination of Monte Carlo and multigroup methods. The agreement between measurements and calculations seems to be consistent with the estimated errors, except for the thermal neutron fine structure or disadvantage factor. There is some indication, as well, of a systematic discrepancy for the BICEP assemblies when the leakage probability exceeds ~20%. (auth)

30251 (BNWL-372) A "POISON-FREE" LOADING OF UO_2 AND Pu-Al IN THE PRCF WITH D_2O-MODERATOR. Uotinen, V. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

A critical loading for a poison-free core for the PRCF was obtained. Fuel was contained in a two-zone loading: an inner zone of natural UO_2 and an outer zone of Pu-Al. The Cd sections of the three control rods, which act as neutron sinks and are normally present in the reactor, were totally withdrawn. Neutron flux measurements were made with this control-rod-free loading. (M.L.S.)

30252 (GA-7381) FEASIBILITY STUDY OF AN ACCELERATOR-BOOSTER, FAST, PULSED RESEARCH REACTOR. Final Report. Stevens, C. A.; Beyster, J. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 25, 1966. Contract AT(04-3)-167. 97p. Dep. CFSTI.

The results of a feasibility study on an accelerator-booster fast pulsed research reactor are presented. Desirable operating characteristics for the booster and its dependence on the associated Linac are outlined. Fast neutron burst shapes and power levels are discussed; problems involved in thermalizing fast neutrons to obtain short intense thermal neutron bursts are examined. Materials requirements and availability for the reactor core, coolant, and reflector are discussed. (M.L.S.)

30253 (IA-1077) RADIONUCLIDES IN THE IRR-1 REACTOR WATER. Proulov, I.; Stiller, M.; Feige, Y. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Mar. 1967. 43p. Dep.

Radiochemical analyses of the pool water of the IRR-1 reactor and of its hot ion exchanger eluates are summarized. The radioisotopes identified are listed as well as their usual concentrations. The probable sources and modes of formation are indicated. The role of these analyses in establishing fuel leaks or any other incidental contamination of the reactor pool water is outlined. (auth)

30254 (IDO-17194) SNAPTRAN-2 DESTRUCTIVE TEST RESULTS. Kessler, W. E.; Weydert, L. N. Jr. (eds.) (Phillips

Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Jan. 1967. Contract AT(10-1)-205. 128p. Dep. CFSTI.

The nuclear, mechanical and radiological behavior of the SNAPTRAN-2 reactor when subjected to a rapid reactivity addition of 5.1 dollars is described. The total energy release was limited to 54 MW-sec primarily by the thermally induced negative reactivity feedback characteristic of the Zr–hydride–U fuel. Rapid core expansion caused by H_2 pressure buildup took place when the fuel temperature reached 1900°F. During dispersal of the burning fuel and H_2, approximately 20% of the fission products was released to the atmosphere. Radiological measurements indicated that the potential six-hour accumulative gamma exposure resulting from the test was less than 10 R at 100 m from the reactor. (auth)

30255 (IN–1078) RETENTION OF IODINE ON SELECTED PARTICULATE FILTERS AND A POROUS SILVER MEMBRANE BEING CONSIDERED FOR THE LOFT MAYPACK. Keller, J. H.; Duce, F. A.; Cartan, F. O. (Idaho Nuclear Corp., Idaho Falls). May 1967. Contract AT(10-1)-1230. 15p. Dep. CFSTI.

Data are presented for the retention of I_2 by three particulate filters and a porous Ag membrane at room temperature. The measured I_2 retentions are a function of the weight of I_2 incident on the filters. The particulate filters retain a larger percentage of the incident I_2 at low iodine exposures. The porous Ag membrane, though a good I_2 trap, loses its high retention efficiency at low I_2 exposures. (auth)

30256 (IN–1100) PROGRAM OF THORIUM INVESTIGATIONS AT THE MTR. deBoisblanc, D. R. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 20, 1956. Contract AT(10-1)-205. 7p. (PTR–44). Dep. CFSTI.

A program to investigate the full potential of Th as an energy source is outlined. The experimental program at the Materials Testing Reactor will include development of ^{233}U assay techniques, long term reactivity effects, determining multiplication constants, fast fission measurements, ^{233}U I–Xe yields, resonance integral measurements, and Doppler temperature coefficients measurements. Estimated costs and manpower requirements are given. (J.C.W.)

30257 (MLM–1395) NEUTRON MULTIPLICATION EXPERIMENT WITH ^{238}Pu DIOXIDE DOUBLE SEALED IN CALORIMETER PRESSURE CONTAINERS. Wolfe, R. A.; Edling, D. A.; Giessing, D. F.; Kahle, J. B.; Stubbins, W. F. (Mound Lab., Miamisburg, Ohio). Jan. 9, 1967. Contract AT(33-1)-Gen-53. 16p. Dep. CFSTI.

The neutron multiplication of high isotopic analysis PuO_2 assembled in various planar arrays in both water and air media was determined. The isotopic distribution of the Pu was approximately 80% ^{238}Pu, 16% ^{239}Pu, 3% ^{240}Pu, and 1% ^{241}Pu. Twenty-one double-sealed calorimeter pressure containers, each containing approximately 130 grams of the ^{238}Pu isotope, were assembled in three planar arrays consisting of 3-in., 1-in., and $\frac{1}{16}$-in. edge-to-edge spacing. No significant neutron multiplication was detectable in the fully assembled 1-in. planar array in the water medium or in the 3-in. planar array in the air medium. A low multiplying region ($M \approx 1.025$) did exist in the $\frac{1}{16}$-in. planar array but was not large enough to be used in reliably extrapolating to the critical mass of ^{238}Pu. (auth)

30258 (ORNL–P–3038) USE OF RESEARCH REACTORS IN RADIATION DAMAGE STUDIES AND IN SOLID STATE AND METAL PHYSICS. Billington, D. S. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 35p. (CONF-670501–11). Dep. CFSTI.

From International Conference on Research Reactor Utilization and Reactor Mathematics, Mexico City, Mex.

Research reactors are unique tools that have an essential role not only in radiation damage studies but also in defect solid state research, neutron scattering studies, and techniques that support solid state research such as isotope production and activation analysis. Results of radiation damage experiments utilizing the BSR and the ORR are described. (J.C.W.)

30259 (ORNL–TM–1808) CRITICAL LATTICES OF HIGH FLUX ISOTOPE REACTOR FUEL ELEMENTS. Johnson, E. B. (Oak Ridge National Lab., Tenn.). Mar. 20 1967. Contract W-7405-eng-26. 10p. Dep. CFSTI.

Lattices of High Flux Isotope Reactor (HFIR) fuel elements were assembled in order to determine the critical spacing between elements when moderated and reflected by water. It was found that seven elements spaced 6.37 in. in a triangular pattern were critical when submerged. Seven outer annuli in the same pattern were critical when separated 1.50 in., and seven inner annuli were subcritical even when in contact. (auth)

30260 (ORNL–TM–1881) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JANUARY, FEBRUARY, AND MARCH OF 1967. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). May 18, 1967. Contract W-7405-eng-26. 43p. Dep. CFSTI.

An operations history of the ORR is given. Maintenance and additions to the facility are outlined. Experiments being currently run in the ORR are tabulated. Reactivity worth measurements are discussed. Radiation damage to the Al test facilities is described. Bowing measurements on the Be pieces are tabulated. Thermal flux measurements made at poolside are listed. (M.L.S.)

30261 (NASA–TN–D–3990) TRANSPORT STUDY OF THE REAL AND ADJOINT FLUX FOR NASA ZERO POWER REACTOR (ZPR-1). Fieno, Daniel (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 88p. CFSTI.

A one-dimensional, multigroup, multiregion Sn transport program for the calculation of real and adjoint fluxes is given. The effects of a small spherical Cd shell are calculated; the real and adjoint fluxes are used to correct experimental reactivity determinations for materials within the shell. The effects of S_n (n even), elastic scattering order (P_0 and P_1), number of spatial mesh intervals, and angular flux model representation on the real and adjoint fluxes, at reactor center and with Cd shell in place, are determined. (M.L.S.)

30262 (PINSTECH/HP–01) MANUAL OF RADIATION SAFETY AND CONTROL FOR PAKISTAN RESEARCH REACTOR. Ahmad, Mansoor; Siddiqi, Aziz A. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Health Physics Div.). 1966. 34p. Dep.

Radiation standards and procedures are established for the safety of the PRR and its operations staff. Procedures are outlined for the general control of radiological hazards, handling of waste disposal, storage of radioactive material, internal transportation of radioactive material, decontamination procedures, and emergencies. (M.L.S.)

30263 (RT/FI–(66)38) CONSIDERAZIONI SULL'ADATTAMENTO DEGLI SPETTRI NEUTRONICI IN UN REATTORE ACCOPPIATO GRAFITE–D_2O. (Determination of Neutron Spectra in a Coupled Graphite–D_2O Reactor). Casali, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 18p. (In Italian). Dep.

The mismatching effect on k_∞ measurements is analyzed for some experiments concerning RB1 reactor loaded with ECO or CIRENE type fuel elements. The theoretical calculations, confirmed by some experimental results, show that the error on k_∞ due to spectral mismatching is of the order of 1% for these D_2O moderated lattices. (auth)

30264 (ANL–Trans–467) OUT-OF-PILE EXPERIMENTS ON POWER EXCURSIONS. Elberg, S.; Nyer, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from paper presented at the Symposium on Heat Exchange During Transients, Cadarache, France, April 26–29, 1966. 43p. (CONF-660455–1). Dep. CFSTI. JCL $4.60 fs, $1.49 mf.

Thermal phenomena occurring in a swimming-pool reactor channel as a result of fast power transients were investigated in out-of-pile experiments. Effects of a short power surge on hydraulic and thermal performance have been determined; the performance of instrumentation under these conditions has been evaluated. All measurements were made with natural convection, only. (M.L.S.)

30265 (ANL–Trans–468) OUT-OF-PILE EXPERIMENTS ON POWER EXCURSIONS. Addendum. Elberg, S.; Nyer, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from paper presented at the Symposium on Heat Exchange During Transients, Cadarache, France, April 26–29, 1966. 15p. (CONF-660455–2). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The results of out-of-pile power excursion experiments are presented. The flow techniques, relative pressurizer air pressure, water height above channel, average flux, average energy dissipated in heater plates, and adiabatic heating of plates are tabulated. (M.L.S.)

30266 PHYSICS EXPERIMENTS TO BE PERFORMED IN SNEAK. Engelmann, P. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirtschaft, 12: 186-90(Apr. 1967). (In German).

Experiments to be performed in the flexible fast zero power reactor SNEAK are physics experiments and mock up studies of power reactors. In physics experiments, data such as critical mass, neutron spectrum, reactivity worth of materials, conversion ratio, Doppler coefficient, and coolant void effects are of

interest. In reactor mock-up experiments, fuel enrichment, power distribution in core and blanket, reactivity worth of control rods, temperature coefficients of reactivity, and coolant-loss reactivity are quantities to be determined. Most experiments performed so far were devoted to the investigation of Na cooled fast reactors. At Karlsruhe steam is also considered a potential fast reactor coolant. The neutronics of fast systems containing hydrogenous materials are not understood. Therefore SNEAK experiments will center on the physics of steam cooled fast reactors. These reactors have a softer neutron spectrum, e.g., the resonance energy region becomes more important. Heterogeneity effects due to the finite thickness of the SNEAK material plates can not be neglected. Fission products and Pu isotopic composition have an increased influence on reactivity and power coefficients. A series of physics experiments are planned to investigate these effects. Mock-ups are also planned for both the Na- and steam-cooled fast prototype reactors. (J.C.W.)

30267 KARLSRUHE FAST ZERO ENERGY ASSEMBLY (SNEAK). Ernst, R. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomwirtschaft, 12: 177-85(Apr. 1967). (In German).

SNEAK is intended to furnish physical and technical data for the design of fast breeder reactors. Critical experiments and core configurations of varying sizes, geometries, materials compositions and amounts of nuclear fuel are envisaged. Variation of these parameters within the core must be possible over wide ranges, within short periods, at high accuracies, and with good reproducibility. A vertical arrangement was chosen for SNEAK, offering high flexibility and extensive experimentation facilities, e.g., the installation of a central loop over the whole length of the core. Reactivity changes in the core are set by shifting fuel sections whose effectiveness is enhanced by following absorber sections. Shutdown, shim, and control rods are used. The structure of the filling corresponds in principle to that of the elements. In the case of the shutdown rod, the filled portion is suspended from a holding magnet. On response of the Safety system or manual actuation, the voltage of the holding magnet is interrupted and at the same time an electro-magnetic pulse transmitter actuated, which overcomes the adhesion force of the holding magnet which does not become ineffective instantaneously and imparts an initial acceleration to the filled section. The filled section of the shim and regulating rods is moved within the protective tube through a spindle drive. Potential sources of hazards accounted for include the operation of the fast zero energy reactor and the handling of partly highly enriched U and Pu. For the protection of the environment, neutron and gamma radiation are reduced to the permissible tolerance values by shieldings in the reactor building. The containment structure was designed as a double steel shell and outward leakage safely prevented by suitable pressurization of the individual compartments. (J.C.W.)

30268 NEUTRON TEMPERATURE AND EPITHERMAL INDEX MEASUREMENTS ON A ORGEL-TYPE CLUSTER. Canalini, D.; Cecchi, P. F. (CNEN, Bologna). Energ. Nucl. (Milan), 14: 350-3(June 1967).

The measurements of Westcott's parameters r and T_n, carried out with Mn, In and Lu, detectors on a ORGEL-type cluster, natural U fueled and diphyl cooled, are described and discussed. (auth)

30269 ON SOME PROPERTIES AND PERFORMANCE OF THE RECOMBINATION SYSTEM OF THE LIGHT WATER HOMOGENEOUS REACTOR, BER. Fischer, C. O.; Wasserroth, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nukleonik, 9: 396-9(May 1967). (In German).

The H_2O_2-gases coming from the core of the BER are recombined in the catalyst bed using Pt–Al pellets. The behavior of this catalyst underwent characteristic changes in the past operation period. These changes are due to formation of catalyst poisons in the core and their transport to the catalyst. Some of these transport phenomena have been investigated. It was possible to identify poisons (I,Br) in the catalyst region by measuring the delayed neutrons. At present it is not possible to understand the relation between the catalyst changes and the observed transport phenomena. (auth)

30270 LONG TERM BEHAVIOR AS AN OPTIMIZATION PROBLEM IN INCREASING THE OUTPUT OF THE FR-2. Kuesters, H.; Mayer, L.; Ott, K. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 9: 353-9(May 1967). (In German).

A second core with UO_2 fuel instead of U metal was investigated for the thermal research reactor FR-2 in Karlsruhe. Taking into account the technical possibilities of the reactor plant, the thermal neutron flux should be as high as possible together with a flat power distribution. As a consequence of the possible high burn up of UO_2 a strong variation of the isotopic concentration and flux will occur during the lifetime of the fuel, so that the usually used stationary design analysis is no longer adequate. Therefore a fast one-dimensional burn up code was developed, which takes into account the changes in the second dimension by an improved and appropriate approximation. Different loading schemes and their influence on integral reactor parameters are discussed in detail to find the conditions for the optimal reactor operation. (auth)

30271 REACTOR KINETICS ACCORDING TO P_1 APPROXIMATION. I. Adalioglu, Ulvi (Istanbul Technical Univ.); Oezemre, Ahmed Yueksel. Nukleonik, 9: 367-72(May 1967).

The derivation of the neutron kinetics equations from the integro-differential neutron diffusion equation is obtained according to P_1 approximation. Some special cases of these kinetics equations are discussed. A mean group of delayed neutrons is taken into consideration and each special case is comparatively studied with respect to a reference reactor in the framework of both the P_1 and the elementary diffusion theoretical approximations. (auth)

30272 EFFICIENCY AND INTERFERENCE OF ROTATING COMPENSATING CYLINDERS AND ABSORPTION RODS IN URANIUM–WATER LATTICES. Krasin, A. K.; Kukhaev, A. I.; Levadnyi, V. A.; Naumov, V. A.; Churkin, Yu. I.; Yaroshevich, O. I. (Inst. of Nuclear Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 9-17(1967). (In Russian).

Excess reactivity in a reactor can be compensated by the use of rotating cylinders covered with an adsorbing material which act as lateral reflectors. The neutron leakage in small, thermal neutron reactors is controlled by the position of the face of the rotating cylinder with respect to the active zone of the reactor. A critical assembly, consisting of 433 fuel rods 10 mm in dia and 500 mm long with 80 g of 10% enriched U (8 g of ^{235}U) per rod, was made up in an Al tank 1.5 m high and 1.6 m high. B_4C with a density of 1.1 g/cm^3 was deposited on compensating cylinders made of Al tubing. The results of calculations and of experimental measurements showed that the compensating rotating cylinders could compensate about 8% excess reactivity. The efficiency of a compensating cylinder with a radius of 5.5 cm in a triangular lattice with a spacing of 16 mm ($\rho_H/\rho_5 = 234$) was approximately equal to the efficiency of a central B_4C absorber rod with a dia of 6 mm. The interference between neighboring compensating cylinders in close array was slight, and was less than 12% of the effiency. The calculated values differed from the experimental results by less than 20%. (TTT)

30273 DISTRIBUTION OF NEUTRON FLUX IN A TWO-DIMENSIONAL CYLINDRICAL MODEL OF IRT-2000 REACTOR. Naumov, V. A.; Veles'ko, A. A. (Inst. of Nuclear Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 18-22(1967). (In Russian).

The neutron energy distribution in the research reactor IRT-2000 was calculated by a digital program for a two-dimensional cylindrical reactor to obtain the neutron spectrum in the active zone, the reflector, the shielding material, and the thermal column. The various components of the actual reactor were replaced by equivalent cylinders for programming purposes. A multigroup diffusion approximation was solved by an iterative method on the counter to give the neutron distribution at 10,500 points within the reactor. The relative distributions of fast neutrons with energies of 4.0 MeV < E < ∞ and of thermal neutrons with E < 0.17 MeV are presented graphically. At distances up to 150 cm from the active zone, the calculated neutron fluxes agreed within 100% with the measured neutron fluxes. The difference in the calculated and experimental values was 50% at distances up to 120 cm from the active zone. (TTT)

30274 REVIEW OF CALCULATION METHODS OF THE EFFICIENCY OF CONTROL RODS AND CORRELATION OF CALCULATED AND EXPERIMENTAL DATA. Kukhaev, A. I. (Inst. of Nuclear Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 30-40(1967). (In Russian).

The efficiency of an absorber is estimated by placing the rod in the center of the active zone and immersing the rod to its full depth. It is assumed that the active zone is small in size, that water is the moderator and that the neutrons are well thermalized. Calculation of rod efficiency by a two-group diffusion approximation shows an error of ~10% in good agreement with the experimental value. Calculations carried out on other heterogeneous reactor lattices by a two- or three-group diffusion approximation are in good agreement with experiment. The accuracy of the calculation depends on the correctness of the boundary conditions that are assumed. The relatively large error obtained in calculating the efficiency by the use of perturbation theory is 30 to 45%, and can be explained by the substantial changes in reactivity, critical volume, and thermal neutron flux that are caused by insertion of the rod. The error of calculating by a three-group numerical method is only 15 to 25%. (TTT)

30275 ALBEDO METHOD OF CALCULATING THE THERMAL NEUTRON UTILIZATION COEFFICIENT. Slizov, V. P.; Rabiner, V. L.; Yurevich, R. V. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 23-9(1967). (In Russian).

The use of elementary diffusion theory in calculating the thermal neutron utilization coefficient (TNUC) leads to errors in heterogeneous lattice systems. More accurate diffusion approximations are laborious to calculate. A simpler method of calculating the TNUC involves expressing the number of absorbed neutrons in terms of the albedo characteristics of each zone of a cell. The general case is considered in which the fuel and moderator can be found in any of three zones of the cell. The albedo of a zone (the probability of a neutron incident on a surface to leave via the same surface), the transmission function (the probability of a neutron incident in a zone surface to strike the opposite surface), and the probability of a neutron's leaving a zone are obtained for an annular zone on the assumption that successive neutron collisions are homogeneously distributed over the volume of the annular space. Calculations are made for two-zoned cells consisting of natural U and graphite as a moderator, for UO_2 rods clad in steel with a ZrH moderator, and for steel-clad UO_2 rods with a heavy water moderator. The ratios of the neutron flux in zone 1 to the flux in zone 2 are given for a number of cells. The results obtained by this simplified method are in good agreement with the results obtained by more sophisticated diffusion methods of calculation or by the Monte Carlo method. (TTT)

30276 CHEMICAL METHODS IN NUCLEAR REACTOR RADIATION DOSIMETRY. Dzantiev, B. G.; Kovaleva, E. P. (Inst. of Nuclear Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 47-51(1967). (In Russian).

The oxidation of ferrous ion to ferric ion, and the rate of consumption of glucose can be used to measure gamma dose and mixed gamma-neutron dose in a reactor. The glucose loss can be measured by the change in optical activity of the solution, or from the change in absorption spectrum of the irradiated glucose solution. These various modifications of chemical dosimetry give results that are in good agreement with each other. The contribution of fast neutrons is 20 to 30% of the total dose, as determined by glucose dosimetry. The dose in the center of the reactor is 1260 rad/sec by ferrous sulfate dosimetry, which is in good agreement with a value of 1220 rad/sec as determined by glucose dosimetry. An ionization method also gave a value in good agreement with the two values obtained by chemical dosimetry. On adding boric acid to the glucose solution, a value of 1.5×10^{12} neutrons cm^{-2} sec^{-1} is obtained for the neutron flux. Thus, chemical dosimetry can be used to determine neutron flux, especially if self-shielding by the boron is taken into account. (TTT)

30277 STOCHASTIC FLUCTUATIONS IN THE POWER PULSES OF TRIGA REACTORS. Baers, Bruno (Technical Univ. of Helsinki, Otaniemi, Finland). Nukleonik, 9: 301(Apr. 1967).

The statistical fluctuations in the peak power and the released energy during a TRIGA reactor power pulse are calculated and compared with experimental observations. (M.L.S.)

30278 CONSTRUCTION OF THE FAST REACTOR EXPERIMENTAL CRITICAL FACILITY. Akehi, Michio (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 42, 182-9(Sept. 1966). (In Japanese).

The fast-reactor experimental critical facility of the Japan Atomic Energy Research Institute was completed. The facility is the first device in Japan for providing fast-reactor cores. In the construction emphasis was placed on safety aspects, and adequate measures are taken against accidents caused by misoperation, malfunctioning of the instruments, failure of the power supply, and earthquakes. An outline is given of the performances and constructions of the mechanical devices constituting the critical facility, which include the lattice assembly, supports, controls, and other accessories. (NSA of Japan)

30279 DETERMINATION OF REACTOR DYNAMIC PARAMETERS THROUGH ANALYSIS OF TRANSIENTS. Pedersen, Joergen (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Nukleonik, 9: 281-4(Apr. 1967). (In German).

A method for determination of the parameters of a physical reactor model is described in which a transient power course is produced by introduction of a known reactivity disturbance in the reactor. The power course is analyzed under the assumption that the reactivity backcoupling in the reactor depends linearly on the power, and the reactor parameters are determined by adapting a theoretical backcoupling function to an experimentally determined backcoupling function. The representation relates especially to the heavy water-moderated reactor DIORIT and some measurement results for this reactor are presented. (tr-auth)

30280 LOADING FACILITIES FOR THE KARLSRUHE FAST ZERO-ENERGY CRITICAL ASSEMBLY (SNEAK). Dose, G. (Krupp-Ardelt, Zweigniederlassung der Fried. Krupp, Wilhelmshaven, Ger.). Kerntechnik, 9: 132-6(Mar.-Apr. 1967). (In German).

A new procedure was adopted for changing the SNEAK core because the core arrangement does not allow inserting the fuel elements from the upper side. Therefore two charging machines are needed: the upper one for lifting the elements and the lower one for positioning the elements and for safety purposes. The transport of the fuel elements from the stock to the lower machine is done by an inclined sluice which bridges over the distance and the difference of altitude. (auth)

30281 SOME COMMENTS ON A STATISTICAL COMPARISON BETWEEN THE CROSS AND AUTO SPECTRA IN NEUTRON MULTIPLYING SYSTEMS. McGrath, E. J.; Albrecht, R. W. (Univ. of Washington, Seattle). Nukleonik, 9: 62-4(Jan. 1967).

A statistical comparison between the estimates for the cross- and auto-spectral functions in a zero-power, point reactor is given. These calculations compare the bias and normalized standard deviation of the two estimates for equal measuring times. It is found, on this basis, that the normalized standard deviation of the cross-spectrum estimate is larger than the same quantity for the auto-spectrum estimate. This result leads one to conclude that for systems where detector efficiency is high and extraneous noise is not a problem the measurement of auto-spectrum is superior to the measurement of cross spectrum. The bias due to finite measuring times enters only at very low frequencies and is nearly identical for the two estimates. The statistical comparisons discussed in this paper necessarily depend on calculations of fourth moments and since these calculations are extremely tedious, only the highlights of the mathematical development of the theory are given. (auth)

Production Reactors

Refer to abstract 28138.

Reactor Components, Fuels and Accessories

Refer also to abstracts 28312, 28339, 28739–28742, 28823, 28872, and 30216.

30282 (ACNP-67516) DESIGN, DEVELOPMENT, AND FABRICATION OF PROTOTYPE LOW-ENRICHED SUPERHEATER FUEL ELEMENTS (LESH). Lampe, D. A.; Raby, T. M. (comps.) (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Apr. 1967. Contract AT(11-1)-589. 132p. Dep. CFSTI.

The development of low-enrichment superheater fuel elements is presented. Mechanical design and analysis is detailed. A thermal and hydraulic analysis is performed. The physics analysis and safeguards analysis are discussed. (M.L.S.)

30283 (BMwF-FBK-67-22) UNTERSUCHUNGEN ZUR BESTRAHLUNGSVERFESTIGUNG VON METALLEN NACH REAKTORBESTRAHLUNG BEI TIEFER TEMPERATUR. (Studies on the Hardening of Metals Due to Low Temperature Reactor Irradiation). Diehl, J.; Decker, W.; Leitz, Chr. (Max-Planck-Institut fuer Metallforschung, Stuttgart (West Germany)). Mar. 1967. 37p. (In German). Dep.

The low temperature irradiation facility of the Karlsruhe Research Reactor FR-2, built for basic studies of the radiation damage of solids, is described. Special attention is paid to the possibilities of this facility for carrying out different types of experiments. A tensile testing machine developed for stress strain tests in the low temperature facility is described in detail. Measurements on the dose dependence of the critical shear stress of Al and Cu single crystals, carried out with this equipment, led to a better understanding of the origin of the irradiation hardening of these metals. (auth)

30284 (GA-7673) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending December 31, 1966. Beyster, J. R.; Antunez, H.; Borgonovi, G.; (and others) (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 25, 1967. Contract AT(04-3)-167. 173p. Dep. CFSTI.

GA-7581 and GA-7608 are included in this report.

Research for the development of thermal scattering kernels is presented. Studies on H_2O have continued and include the corrections for multiple scattering to the double differential data. The angular scattering measurements performed on H_2O have been summarized. The total cross section measurements in H_2O have been reanalyzed and compared with the predictions of the various

theoretical models. Further angular scattering measurements have been made on zirconium hydride at elevated temperatures. Thermal spectrum measurements have been made in Be metal at liquid N_2 temperatures as a function of position. The position dependent spectral measurements in ^{238}U in the resonance energy region are analyzed and experimental and theoretical discrepancies are encountered. An improved theoretical model for benzene is described. Simple bound scattering models for UC and UO_2 have been formulated. Experimental studies included fast spectrum measurements in ^{238}U. Kinetic studies on multiplying and nonmultiplying fast assemblies in the ^{238}U sphere continue. (J.C.W.)

30285 (IDO-17230) NONDESTRUCTIVE FLAW DETECTION BY USE OF ACOUSTIC EMISSIONS. Parry, D. L. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1967. Contract AT(10-1)-205. 44p. Dep. CFSTI.

A requirement exists for a safeguards system that will ensure the integrity of the primary loop of a nuclear power installation. To meet this requirement, a technique of detecting the acoustic emissions of materials under stress has been applied as a nondestructive diagnostics tool for reactor pressure vessel and primary loop flaw analysis. The presence of a flaw in a metal under stress is evidenced by the low threshold of appearance for the acoustic signals, by an occurrence of burst signals, and by the increase in the continuous-emission-signal intensity with applied stress. Investigations into the feasibility of applying the acoustics phenomena as a safeguards system for ensuring primary loop integrity are being conducted as a test program. This test program has been developed around large-scale, complex reactor vessel testing, supplemented by laboratory-scale tensile-specimen testing. Acoustic signals have been successfully detected, recorded, and analyzed from two complex, embrittled pressure vessels tested under conditions of applied stress. The acoustic data were recorded on magnetic tape which was post-test analyzed by instrumentation systems designed to relate the detected acoustic signal characteristics with such test parameters as applied stress, stress rate, and material flaw size. Tensile specimen testing has been used for the detection, recording, and analysis of the continuous-emission-type acoustic signal. It has enabled the instrumentation of a detection and analysis system which allows the interpretation of the continuous-emission signal on a signal rate versus strain and/or stress basis. The continuous-emission-type signal has been shown to have essentially no threshold effect, appearing instantaneously with the first stress. It is statistically rich, and initial investigations into statistical time distribution analysis have indicated strongly that it may provide sufficient data for determining flaw size, growth rate, and prediction of the failure-stress value. Continuous-emission data and burst data have indicated the possibility of using the emission phenomena for determining metal characteristics such as ductility and nonstress. (auth)

30286 (KFK-477) UEBER THERMODYNAMISCHE VORGAENGE IN BRENNELEMENTEN MIT ERMITTLUNG DER TEMPERATURVERTEILUNG. (Thermodynamic Processes in Fuel Elements With Determination of the Temperature Distribution). Sundermann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Feb. 1967. 10p. (In German). Dep.

The possible effect of various thermodynamic processes on fuel elements was considered. The effect of fission gas distribution with respect to the equilibrium standardization with consideration of diffusion processes was discussed. The surface voltage and the heat induction in the fuel element at varying local temperatures was also considered. The general effect of the temperature on the fuel element cladding was indicated. (tr-auth)

30287 (ORNL-TM-1633) COMPUTER CODE TONG FOR ZERO-DIMENSIONAL REACTOR DEPLETION CALCULATIONS. Vondy, D. R.; Fowler, T. B. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 131p. Dep. CFSTI.

A multigroup point-depletion calculation was programmed (FORTRAN II) for the IBM-7090. The 68-group fast-neutron code GAM, which will process resonance parameters, and the 30-group thermal-neutron one-dimensional code THERMOS were modified and incorporated in the program, which is designated TONG. The NUCY code technique was used for an explicit solution of any set of interlocked nuclide chain equations. The program tape can be used to prepare MODRIC or EXTERMINATOR cross sections or to make individual GAM or THERMOS calculations. A number of modifications were made in the GAM and THERMOS programs to increase flexibility. Fuel-cycle costs may be determined and intermittent once-through fuel movement, or scatter refueling, can be considered. (auth)

30288 (WCAP-3791-4) URANIUM PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1967. Ray, William E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr. 1967. Contract AT(30-1)-3791. 46p. Dep. CFSTI.

Research and development are reported on fuel material fabrication development, and fuel element fabrication. Results of thermal flux irradiation, fastflux irradiation, and transient flux irradiation studies are included. (J.R.D.)

30289 FABRICATION OF DENSE UO_2 BY HOT PRESSING AND COEXTRUSION. Masssaux, H.; Van Asbroeck, Ph.; Mestdagh, G.; Pech, G. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Energ. Nucl. (Milan), 14: 354-64(June 1967).

A study of these methods revealed that it is possible to prepare dense UO_2 with characteristics suitable for fabrication into fuel elements by vibrocompaction. Short- and long-term irradiation is necessary to evaluate the advantages hot-pressed UO_2 has over other types of UO_2. (J.R.D.)

30290 THE IAEA SYMPOSIUM ON PLUTONIUM AT BRUSSELS (MARCH 13-17, 1967). Bonalumi, R. (Laboratori CISE, Milan). Energ. Nucl. (Milan), 14: 365-73(June 1967). (In Italian).

Topics considered include availability of Pu, recycle of Pu in thermal reactors, technological aspects of Pu fuels, and physics of thermal reactor lattices containing Pu. Studies on Pu recycle, whose feasibility is by now technically ascertained and whose main problem concerns the optimization of development programs and technological processes are of interest. Studies on the fabrication and performance of Pu fuels show that they are homogeneous in comparison with fuels containing no Pu. (auth)

30291 ON THE USE OF BORON COMPOUNDS IN GAS COOLED HIGH TEMPERATURE REACTORS. II. COMPATIBILITY OF BORON-CONTAINING COATED PARTICLES AND BORONATED GRAPHITE WITH GRAPHITE. Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 9: 372-80 (May 1967). (In German).

The use of graphite fuel elements which contain B compounds as absorber and/or burnable-poison materials, in gas-cooled high-temperature reactors is discussed. The compatibility of coated particles containing B_4C and boronated graphite with graphite at 1000°C is examined. All particles containing a dense isotropic high-temperature pyrolytic-carbon layer are found suitable. A small amount of B transfer through the pyrolytic C layer into the surrounding graphite matrix with longer annealing times at high temperature cannot be completely avoided. As revealed by thermodynamic estimations and by compatibility experiments on mixtures of graphite and various borides of the 4-th and 5-th subgroups of the periodic table certain borides are particularly stable in contact with graphite at reactor temperatures of interest. (auth)

30292 PERMEABILITY OF GRAPHITE FOR VOLATILE FISSION PRODUCTS. Laser, M.; Kirchner, H. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 9: 385-9(May 1967). (In German).

The results on diffusion of fission products in graphite show in many cases no fulfilment of Fick's law. It may be assumed therefore, that the diffusion is superposed by a chemical reaction. Since for the calculation of formation of such compounds most of the thermodynamic data are unknown, the heats of formation of alkaline earth and rare earth dicarbides were estimated by a Born-Haber cycle. The partial pressure above dicarbides and consequently the rate of evaporation of fission products is therefore in most cases lower than for the corresponding metals. Also the diffusion across the pyrocarbon coating or graphite can depend upon the partial pressure built up relative to the concentration gradient. Finally, in porous graphite the mass transport of fission products seems to proceed partially via the gas phase. The great differences observed for the diffusion coefficient of Ba and Sr can be explained half-quantitatively by the different partial pressures. An effective decontamination of carbide nuclear fuels by evaporation of the most important neutron poisons at temperatures above 2000°C seems to be problematic. Rising temperatures entails increasing evaporation rates, but on the other hand the partial pressure curves of U and fission products are approaching each other more and more. (auth)

30293 NEW EXPERIMENTAL FEASIBILITY FOR THE RESEARCH IN RARE GAS DIFFUSION IN FISSILE MATERIAL. RARE GASES IN SOLID SUBSTANCES. REPORT 30. Felix, F. W.; Seelig, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nukleonik, 9: 389-92(May 1967). (In German).

The production of radioactive rare gases in solids by neutron irradiation was systematically studied. Methods for the separation and quantitative monitoring of the gases were developed. These methods allow to determine the simultaneous diffusion of Ar, Kr, Xe, and I in a suitable solid by a simple measurement

of the gaseous activity, i.e., without gas chromatographic separation or pulse height analysis. Examples for gas diffusion measurements in single crystals of UO_2, UC and U-doped CaF_2 are given. (auth)

30294 ON THE PRACTICAL CALCULATION FOR THE RELEASE OF FISSION GASES FROM URANIUM DIOXIDE FUEL ELEMENTS. RARE GASES IN SOLID SUBSTANCES. REPORT 31. Biersack, Jochen (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nukleonik, 9: 393-5(May 1967). (In German).

The various transport mechanisms for fission gas atoms are briefly discussed and a set of formulas is given for the calculation of the fission gas release, taking into account the motion of gas-filled bubbles to the center of the fuel rod. (auth)

30295 THE CHEMISTRY OF HYDROGEN IN LIQUID-ALKALI-METAL MIXTURES USEFUL AS NUCLEAR REACTOR COOLANTS. I. SODIUM-POTASSIUM EUTECTIC. Compere, Edgar L.; Savolainen, Jouko E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Sci. Eng., 28: 325-37(June 1967). (ORNL-P-2341).

The solubility of H_2 in liquid alkali metals as nuclear reactor coolants varies significantly with pressure and temperature. The solubility of hydrogen in eutectic NaK-78 was determined at six temperatures from 300 to 704°C and at pressures below one atmosphere. For unsaturated solutions, the solubility depended on the square root of the H_2 pressure and varied only slightly with temperature. At temperatures of 300 to 400°C, enough H_2 could be dissolved at pressures below one atmosphere to result in precipitation of a metal hydride. Precipitation-decomposition pressures were consistent with the literature. The addition to NaK-78 of 1 to 4 at. % Li were considerably diminished the hydrogen activity and resulted in precipitation at lower hydrogen pressure. A mass action model is postulated to explain the phenomena. It is suggested that in liquid-alkali-metal mixtures, dissolved hydrogen exists largely in the form of undissociated metal-hydride molecules or ion pairs, with the different metals combining with the hydrogen in proportion to their concentration and their affinity for hydrogen. (auth)

30296 DISCUSSION ON THE CALCULATION OF FUEL ELEMENT COST. Gruemm, H. Atomwirtschaft, 12: 146-7(Mar. 1967). (In German).

A rebuttal is given of the criticisms by Gudehus of the author's original article on "Simplified Method for the Calculation of Fuel Cost Components." (J.S.R.)

30297 FABRICATION OF REACTOR PRESSURE VESSELS AND REACTOR COMPONENTS WITH SPECIAL REGARD TO WELDING. Sudasch, E.; Bergmann-Franke, W. (Gutehoffnungshuette Sterkrade AG, Oberhausen-Sterkrade, Ger.). Kerntechnik, 9: 137-47(Mar.-Apr. 1967). (In German).

The problems of making all-weld pressure vessels, the metallurgical problems, and the various welding processes are discussed. The successful application of the electro-slag welding process for making longitudinal seams on vessel strakes, spherical heads and flange rings is dependent on the accuracy of shaping thick plates on bending rolls and presses. For welding the circumferential seams and for connecting the large flanges, nozzles, etc., the submerged-arc welding process is particulary advantageous. Most of this equipment is protected against corrosion by a weld overlay, which is also applied by the submerged-arc process, using strip electrodes; the choice of the correct weld metals and the proper execution of this kind of welding are of decisive importance. The tube sheets of tubular apparatus are drilled on modern high-precision machines. Fixing of the tubes in the tube sheets is generally made by welding and rolling; such welding is done with automatic machines. (auth)

30298 ELECTRON-BEAM WELDING OF FUEL ELEMENTS FILLED WITH UO_2-PuO_2. Scheibe, W. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Kerntechnik, 9: 148-51 (Mar.-Apr. 1967). (In German).

Fuel elements with UO_2-PuO_2 fuel were closed by electron beam welding. The Pu fraction requires special safety precautions which result in a remotely controlled welding process. In order to obtain smooth welding seams free from annealing colors, the tubes were evacuated over sintered steel filters. Measures of keeping within the extreme requirements of dimensional tolerances and surface quality of the tubes are described. The causes which may result in faulty welds are reported. (auth)

30299 WELDING OF SAP. Klersy, R.; Musso, G. (EURATOM, Ispra, Italy). Kerntechnik, 9: 152-7(Mar.-Apr. 1967). (In German).

Welding procedures which have been developed for the use of SAP as canning material for nuclear fuel elements are described. Arc welding, electron-beam welding, diffusion welding and welding with plastic deformation are separately treated. The electron-beam welding has been applied successfully. Best results have been obtained by a method with plastic deformation, now being developed into an industrial process. (auth)

30300 FISSION PRODUCT TRANSFER IN THE SYSTEM UO_2/LIQUID SODIUM/STAINLESS STEEL. Keil, H.; Scherff, H. L.; Lindner, R. (CCR-EURATOM, Ispra, Italy). Atomkernenergie, 12: 96-100(Mar.-Apr. 1967).

Fission product (FP) transfer from UO_2 powder through liquid Na towards stainless steel has been investigated and the diffusion of FP, U and Pu in stainless steel been measured at 700 to 1000°C. Diffusion coefficients and activation energies are stated. (auth)

30301 ANGLE FACTORS FOR THE FUEL CLUSTER OF NUCLEAR REACTOR IN RADIATIVE HEAT TRANSFER. Amano, Kenichi (Meidensha Electric Mfg. Co., Ltd., Japan). Meidensha Jiho, No. 68, 26-31(June 1966). (In Japanese).

Calculations of heat removal in reactor channels containing fuel clusters and the use of angle factors is required to incorporate radiative heat transfer. Since angle factors depend on the geometrical relation between the surfaces and the surface conditions, it is usually difficult to obtain these factors analytically. However, when it is assumed that the radiation is diffusive, the surfaces are grey, the medium between the surfaces is not absorptive and the cluster consists of infinitely long parallel rods, the angle factors can be obtained analytically; but these can also be given by the construction. (NSA of Japan)

30302 STRESS ANALYSIS OF FLANGED PARTS IN THE PRESSURE VESSEL BY THE ELASTIC TEST OF THREE DIMENSIONAL LIGHT. Amano, Makio; Yokoyama, Yoshisumi (Ishikawajima-Harima Heavy Ind. Co., Ltd., Japan). Nippon Kikai Gakkai Rombunshu, 32: 533-40(Apr. 1966). (In Japanese).

It is important to know the stress concentrations in such discontinuous parts as the panels and body flanges for reactor pressure vessels. The local stresses were determined, and the relation was obtained between the fillet radius or the flange shape and the stress concentration coefficient. For the panel flanges the maximum local stress occurred at the fillet R part as a stress in the outward meridian direction. The effect of the fillet radius on the stress concentration was found to be small and the increase in the thickness of the flange was found to be effective with respect to the stress concentration. For the body flanges, the stress concentration differed largely according to their shapes. In the ordinary flanges, the maximum local stress occurred as a stress in the outward circumferential direction. As the bolting force was constant in all models, no relation was obtained between the bolting force and the stress concentration coefficient. As seen from the distribution of stresses in the meridian direction, the effect of the bending moment due to the bolting was very large. (NSA of Japan)

30303 MODERATOR MATERIALS. Reactor Mater., 10: 20-3(Spring 1967).

A review of recent research development on reactor moderator materials is presented. (18 references). (J.C.W.)

30304 NUCLEAR POISONS. Reactor Mater., 10: 24-5(Spring 1967).

A review of recent research development on nuclear poisons is presented. (9 references). (J.C.W.)

30305 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 10: 26-58(Spring 1967).

A review of recent research development on nuclear cladding and structural materials is presented. (152 references). (J.C.W.)

30306 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 10: 59-67(Spring 1967).

A review of recent developments in special fabrication techniques for nuclear materials is presented. (J.R.D.)

30307 TEPLOVYDELYAYUSHCHIE ELEMENTY ATOMNYKH REAKTOROV. (Fuel Elements for Nuclear Reactors). Zaimovskii, A. S.; Kalashnikov, V. V.; Golovnin, I. S. Moscow, Atomizdat, 1966. 520p.

The general specifications for reactor fuel elements are analyzed. Their manufacture, specifications, and use are outlined. The construction materials of the nuclear fuels are examined. The compatibility of the nuclear fuel with the construction materials is analyzed. The collective effects of thermal, mechanical, and radiation effects on fuels and construction materials are examined. (tr-auth)

30308 IMPROVEMENTS IN FUEL ELEMENTS. (to Babcock and Wilcox Co.). British Patent 1,071,363. June 7, 1967. Priority date July 7, 1964, United States.

A design for a plate-type fuel element is given. The plate has a

fissile core and cladding, designed such that the fissile core displacement is minimized. Fabrication techniques for the fuel element are detailed. (M.L.S.)

30309 NUCLEAR REACTOR INSTALLATIONS INCLUDING A REFUELLING MACHINE. Middleton, John Ernest; Emerson, David Colin (to United Kingdom Atomic Energy Authority). British Patent 1,070,939. June 7, 1967. Filed May 13, 1964.

A design for a reactor loading machine which is electrically supported on rotatable shields above the reactor core is given. A two-link fluid flow connection is provided for the loading device. (M.L.S.)

30310 METHOD OF MANUFACTURING FUEL ELEMENTS. Smith, Samuel Spenceley; Hayfield, Peter Charles Steele (to Nuclear Developments Ltd.). British Patent 1,060,833. Mar. 8, 1967. Filed Mar. 13, 1964.

A method is described for making fuel elements of U for nuclear reactors. The process comprises pretreatment of the U rods to remove corrosion products, dirt, scale, and particles of UC, roughing the surface to secure better adhesion of the coating, embedding the rod in Mg powder, and heating in an inert atmosphere at a temperature sufficiently high to develop a continuous coating of Mg. The Mg coated rod is then placed in a Mg or Mg alloy can and autogenously welded to the can. Modifications of the method comprise anodizing the rods before coating with Mg and heating in an atmosphere of UBr_4. (P.G.C.)

30311 APPARATUS CAPABLE OF PERMITTING THE TRANSFER TOWARDS THE OUTSIDE OF PARTS OR APPARATUS FROM PRESSURIZED VESSELS OR FROM VESSELS CONFINING CONTAMINATED CONTENTS. (to Snam S.p.A). British Patent 1,070,990. June 7, 1967. Priority date Mar. 12, 1964, Italy.

A device designed for the safe removal of a gas circulating pump mounted in a pressure vessel is described with special means (twin gate valves) for maintaining the integrity of the gas pressure is described. (R.E.U.)

30312 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Morrison, Ian Hugh (to United Kingdom Atomic Energy Authority). British Patent 1,062,035. Mar. 15, 1967. Filed Aug. 22, 1963.

A method for fabricating cylindrical nuclear reactor fuel element sheaths, each of which has a herringbone configuration of heat transfer fins, is described. The sheaths are produced by extrusion of hollow cylindrical metal bodies having longitudinal fins, and twisting the body either right-handedly or left-handedly to transform the fins from longitudinal to coarse-pitch helical configuration. The separately produced bodies, having either right-handed or left-handed fins are joined in a leak-tight manner by butt welding. The configuration described reduces lateral instability in the fuel element due to forces exerted by the coolant. (P.G.C.)

30313 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Meredith, Keith Edward George (to Central Electricity Generating Board). British Patent 1,071,411. June 7, 1967. Filed Jan. 29, 1963.

A method of canning of fuel elements is given. The procedures for canning and fabrication are detailed. (M.L.S.)

GENERAL

30314 (AWRE/LIB/BIB-16) LIST OF UNCLASSIFIED PUBLICATIONS AND AWRE REPORTS BY STAFF OF THE WEAPONS GROUP PUBLISHED DURING THE YEAR 1966. Every, R. S. (comp.) (Atomic Weapons Research Establishment, Aldermaston (England)). May 1967. 41p. Dep. CFSTI. UK 5s. 6d.

A list of 142 titles of publications and reports is presented for the year 1966. The following subject categories are represented: biology, medicine, agriculture, chemistry, chemical engineering, instrumentation, geology and mineralogy, health and safety, industrial applications of isotopes and radiations, isotope separation, mathematics and computers, metallurgy and materials, radiation effects on materials, physics, plasma physics, particle accelerators, reactor physics, reactor technology, and waste disposal. (H.L.W.)

30315 (AWRE-O-38/67) THE INTERACTION OF A LONG DURATION FRIEDLANDER SHAPED BLAST WAVE WITH AN INFINITELY LONG RIGHT CIRCULAR CYLINDER. INCIDENT BLAST WAVE 20.7 PSI, POSITIVE DURATION 50 MS AND A 16 CM DIAMETER CYLINDER. Bishop, Valerie J.; Rowe, R. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1967. 61p. Dep. CFSTI. HMSO 10s. 0d.

Studies of the effect of subjecting a 16 cm diameter infinite cylinder to a 50 ms duration Friedlander shaped blast wave, 20.7 psi peak shock overpressure, at a maximum Reynolds number of 3.75×10^6 and Mach number of 0.6, are reported. Piezoelectric pressure gauge measurements were used to compute pressure coefficient, average translational force, and drag coefficient. From this work, it was concluded that the shapes of the pressure coefficient-time curves obtained show general agreement with steady state work and their values are of the same order of magnitude. The drag coefficients computed, except for the initial shock-interaction phase, are of the same order of magnitude as the steady state values obtained for comparable Reynolds and Mach numbers. (auth)

30316 (COO-1469-0038) WEAK CONGRUENCE RELATIONS ON GRAPHS. Report No. 213. Yeh, Raymond Tzuu-Yau (Illinois Univ., Urbana. Dept. of Computer Science). Sept. 1, 1966. Contract AT(11-1)-1469. 47p. Dep. CFSTI.

Thesis.

The concepts of homomorphic relations (multi-value homomorphisms), weak congruence relations and covers with substitution property on generalized graphs are investigated. (B.G.D.)

30317 (COO-1469-0051) NUMERICAL INTEGRATION OF STIFF ORDINARY DIFFERENTIAL EQUATIONS. Report No. 221. Gear, C. W. (Illinois Univ., Urbana. Dept. of Computer Science). Jan. 20, 1967. Contract AT(11-1)-1469. 24p. Dep. CFSTI.

Stiff equations are ones in which there are rapidly decaying components which are of no interest because of their small magnitude. Equations of this form frequently arise in physical equilibrium problems such as chemical or nuclear reactions where there are many components with a large range of time constants. Although the rapidly decaying components are of small magnitude, they cause severe numerical problems in most general purpose integration methods. The cause of these problems is examined and some ways around them are proposed. Some specific methods are developed, but the investigation of classes of methods remains to be done. (auth)

30318 (IS-T-130) DYNAMIC MASS TRANSFER MEASUREMENTS IN FALLING DROPS. Scholle, William Allen (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 79p. Dep. CFSTI.

Thesis.

Mass transfer measurements were made from falling drops by relating their velocity of fall to their density. Formation data were obtained by comparing the fall velocities of drops that formed on a tip to drops having no mass transfer during formation. For the system of carbon tetrachloride-benzene, aqueous sodium iodide solution, and iodine, the rate of fall was strongly dependent on the iodine concentration in the drop. During the fall period there was a change in the mass transfer mechanism corresponding to a transition from circulation to non-circulation within the drop. During formation the drop was well mixed and most of the resistance to mass transfer was in the continuous phase. A rapid build up of solute on the outside of the drop caused an additional resistance while the high solute density caused a flow of solute along the surface of the drop tending to decrease the resistance. (auth)

30319 (K-L-6139) AUTOMATIC CARBOHYDRATE ANALYZER OPERATION AND MAINTENANCE MANUAL. Stevens, R. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 26, 1967. Contract W-7405-eng-26. 87p. Dep. CFSTI.

For Drawings see CAPE-1572.

A high-pressure liquid chromatography system for separating and analyzing saccharidic components in solutions of mixed carbohydrates on a programmable automatic basis is described. (B.G.D.)

30320 (LA-3661) INITIAL WARMUP OF 500,000-GALLON LIQUID HYDROGEN DEWAR. Liebenberg, D. H.; Murley, E. (Los Alamos Scientific Lab., N. Mex.). Mar. 22, 1967. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A 500,000-gal liquid hydrogen dewar was warmed to ambient temperature by breaking the annular space with a small quantity of gaseous nitrogen and using an installed 32.3-kW electric heater. Some previously reported hazards were not observed using this procedure. Observations indicated the energy required to warm the perlite insulation is less than that calculated using present theory. (D.E.B.)

30321 (NP-16759) THE RADIATION PRODUCED BY AN ARBITRARILY ORIENTED DIPOLE IN AN INFINITE, HOMOGENEOUS, WARM, ANISOTROPIC PLASMA. Schultz, F. V.; Graff, Robert William (Purdue Univ., Lafayette, Ind. School of Electrical Engineering). Dec. 1966. 211p. (TR-EE-66-22).

An expression for the electric field produced by an arbitrarily oriented electric dipole in a warm, anisotropic, single-fluid plasma is derived. The radiation patterns are found for the specific example of a dipole oriented perpendicularly to the externally impressed magnetic field, for a plasma in which $\omega_p = 0.412\ \omega$, $\omega_c = 0.75\ \omega$, $\omega = 3 \times 10^9$ radians per second, and $U = 0.003$ c. Results are found to be consistent with previous analyses, yet show significant changes produced by the consideration of electron temperature. Large maxima of radiation were found in the endfire direction, which are not found by the cold-plasma analysis. The procedure of analysis was to reduce the governing equations for this model to a single inhomogeneous wave equation in the electric field intensity, $\bar{E}$, and to subsequently introduce a dyadic Green's function representation for $\bar{E}$. The resulting homogeneous equation in the Green's function dyadic, $\bar{G}$, was then Fourier-transformed, and the algebraic equations produced were then solved for $\bar{G}$. One can, by a sixfold integration, find the field intensity due to any finite current configuration $\bar{J}_s(\bar{r}')$, using this result. (auth)

30322 (NVO-98-29) DEEP OCEAN SURFACE WAVE MEASURING BUOY SYSTEM. Metzler, Allan R.; Olsen, Kenneth H. (Interstate Electronics Corp., Anaheim, Calif. Oceanics Div.). Apr. 1967. Contract AT(26-1)-98. 14p. (CONF-670608-1). Dep. CFSTI.

From 3rd Annual National Marine Technology Society Conference, San Diego, Calif.

Two taut wire buoy systems have been concurrently placed in 15,000 feet of water for the purpose of measuring long period surface waves. Spectral density data are presented showing a resolution capability less than one centimeter of water height in the band of interest. The buoy motions have been previously instrumented to define and confirm the types of subsurface motion effecting the dual vibrating wire pressure transducer. Temperature of the transducer is also continuously monitored to correct the pressure data in the computer. To further isolate the pressure sensor, thermal insulation provides a temperature time constant well outside the band of interest. Data are continuously transmitted to shore via a skiff mounted FM telemetry system and digitally stored on magnetic tape for computer analysis. (auth)

30323 (ORNL-4102) REMARKS ON ESTIMATION PROBLEMS FOR THE PARAMETERS OF THE NEYMAN TYPE A DISTRIBUTION. Bowman, K. O.; Shenton, L. R. (Oak Ridge National Lab., Tenn.). May 1967. 62p. Dep. CFSTI.

The Neyman Type A distribution defined on the non-negative integers depends on two parameters Θ_1, Θ_2, and is structurally the simplest of the Neyman contagious distributions. These have wide application in biology, ecology and other branches of natural science. At the present time very little is known about the distributional properties of the estimators of the parameters involved, and large sample theory is invoked with naive uncriticality. The study which is confined to the Type A distribution shows that moment estimators only have moments in a conditional sense, and that in their expansions higher order asymptotics may dominate the traditional lower order terms, in particular in two regions of the parameter space. The first region is that part of the parame-

ter space in which the index of dispersion or contagion Θ_2 is small; here the distribution becomes tangential to the Poisson distribution. The second region is that part of the parameter space contained by a parabolic arc sweeping away from the origin with an axis inclination of about 45°; within this region the distribution has high modality, the modes being spaced at intervals of Θ_2 approximately. In both these regions samples of more than 500 may be required to give the appearance of stability to the moment expansions of moment statistics and maximum likelihood statistics. As a rough assessment the estimators of Θ_1 (the index parameter) require larger samples for stabilization than those for Θ_2. Again the sample size is about the same for moment and maximum likelihood estimators. Moreover, in general, a larger sample is needed for a higher moment than for a lower moment. Critical remarks are also offered on the meaning of asymptotic efficiency and its misleading undertones. (auth)

30324 (ORNL-TM-1842) SOLUTIONS TO ELECTROMAGNETIC INDUCTION PROBLEMS. Dodd, Caius Vernon (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 92p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Methods of solving electromagnetic induction problems by use of the vector potential are discussed. The differential equations for the vector potential are deriv[illegible] from Maxwell's equations, and cylindrical symmetry is ass[illegible]ed. This differential equation is then solved by two different t[illegible]c techniques: a closed form solution and a relaxation solutio[illegible]. For the closed form solution, sinusoidal driving currents and linear, isotropic, and homogeneous media are assumed. The differential equation is solved for two different conductor configurations; a rectangular cross-section coil above a plane with one conductor clad on another and a rectangular cross-section coil encircling a two conductor rod. The solutions for both configurations are given in terms of integrals of Bessel functions. The relaxation method is used for three different cases, the first being that for an applied current with a sinusoidal time dependence in a linear, isotropic, and inhomogeneous medium. The second case is a time sequential relaxation for an applied current with any type of time dependence in a linear, isotropic, and inhomogeneous medium. The third case is the same as the second, except the medium may be nonlinear. In the relaxation method finite difference approximations are made for all terms in the differential equation, and the vector potential at every point is expressed in terms of the vector potential at neighboring points. The vector potential at every point may then be solved using a relaxation (iteration) technique for any particular configuration of coil and material. Once the vector potential is determined, any physically observable electromagnetic phenomenon can be calculated from it. Equations are given for the eddy-current density, heating density, force density, induced voltages, and coil impedance for both perfect metals and metals with defects. Examples of the application of the relaxation technique to solve these problems and experimental verification of the answers are given. In most cases the agreement between calculated and measured values is good. These two techniques will allow the solution of a large number of electromagnetic induction problems. (auth)

30325 (SC-CR-67-2580) FLYING PLATE PLANE WAVE GENERATORS. Final Report. Stanton, Philip L. (Texas Univ., Austin. Engineering Mechanics Research Lab.). Mar. 30, 1967. Contracts AT(29-1)-789; 13-0787. 45p. (EMRL-TR-1012). Dep. CFSTI.

Techniques were developed for die-forming cones with precision contours, and instrumentation has been prepared for both optical planarity measurements and electronic measurements of the transmitted stress wave through impacted materials. Experimental results indicate that a useful range of impact velocities and pulse durations can be achieved using the die-formed plane wave generator. In some design of the die-formed plane wave generator, the center region has been found to misbehave. It is believed that the problem stems from non-uniform behavior of the detonation wave with distance from point of initiation. The solution requires minimizing the plate and housing masses. No definitive conclusions regarding the flying plate plane wave generator, or the propagation of waves in materials impacted by the plate are justifiable at this time. (auth)

30326 (SC-DC-67-1787) ON-BOARD SIGNAL CONDITIONING FOR PIEZOELECTRIC ACCELEROMETERS. Arlowe, H. D.; Holmes, G. W. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 13p. (CONF-670903-2). Dep. CFSTI.

For Presentation at 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

Some traditional and current problems involved in collecting data from hard wire accelerometer instrumentation are described. Design concepts and problems are covered which pertain to a suitable on-board high impedance line driver. Finally, a pulse width modulation technique is discussed which appears to overcome many of the current on-board instrumentation problems. (auth)

30327 (SC-DR-66-2707) DESIGN AND DEVELOPMENT OF A THREE-STAGE PARACHUTE SYSTEM FOR LOW-LEVEL DEPLOYMENT UP TO MACH 1.2. Pepper, William B. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT-(29-1)-789. 42p. Dep. CFSTI.

The design and development of a parachute system suitable for low-level release and high-velocity deployment are presented. Rocket-boosted field tests of the system along with theoretical trajectory studies indicate that the retardation system can successfully recover a 1300-pound test vehicle released from an aircraft flying at Mach 1.2 and 150 feet above the terrain. (auth)

30328 (SC-RR-66-2608) AEROBALLISTIC DEVELOPMENT OF THE SINGLE STAGE TOMAHAWK SOUNDING ROCKET SYSTEM. Gardner, R. E. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 44p. Dep. CFSTI.

The Single Stage Tomahawk is a solid-propellant sounding rocket system capable of carrying a 125-pound payload to an apogee altitude of about 250,000 feet when launched from sea level. Aerodynamic design data, performance and dispersion estimates, and a summary of flight tests of the system are presented. (auth)

30329 (SC-RR-67-287) BOUNDARY CONDITIONS FOR PERSISTENT ROLL RESONANCE ON RE-ENTRY VEHICLES. Vaughn, Harold R. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 39p. Dep. CFSTI.

The boundary conditions that determine whether transient roll resonance, or the more serious persistent roll resonance, will occur on a reentry vehicle are determined theoretically for the condition of small angle of attack. (auth)

30330 (SC-TM-67-208) DESIGN OF A SPECIAL OIL-INSULATED HIGH-VOLTAGE PULSE TRANSFORMER. Spencer, C. E.; Kerley, P. L. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 13p. Dep. CFSTI.

The design, performance, and construction of a small high-voltage pulse transformer that uses oil instead of epoxy for an insulating medium is described. The transformer uses a multilayer secondary with a 21:1 stepup ratio to generate 150-kilovolt, 15-microsecond pulses into a 10-kilohm load at repetition rates of 10 pulses per second. The transformer was built for use with the British K Type 1 neutron tube for use under water next to the fueled core of a Godiva-type reactor to determine reactor parameters. (auth)

30331 (SC-TM-67-334) FILTER WHEEL PHOTOMETER FOR CARIBOO II. Herrington, P. B. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 13p. Dep. CFSTI.

The Filter Wheel Photometer, designed for Cariboo II, including techniques for calibrating the optical system of the photometer is described. (auth)

30332 (SCL-DR-67-24) NEW DESIGN OF CF CABLES. Balaban, J. A. (Sandia Corp., Livermore, Calif.). May 1967. Contract AT(29-1)-789. 21p. Dep. CFSTI.

A new method of making firing cables (CF cables), utilizing various combinations of shrink-fitted sleeves and boots with encapsulating compounds, produces cables that will meet a wide range of electrical, mechanical, and environmental requirements. A typical step-by-step assembly procedure is given. (auth)

30333 (SCL-DR-67-34) THREE-INCH, COLD-GAS SHOCK TUBE. Thompson, R. A. (Sandia Corp., Livermore, Calif.). June 1967. Contract AT(29-1)-789. 27p. Dep. CFSTI.

A three-inch, cold-gas shock tube has been developed and installed at Livermore Laboratory. The facility has the capability of a maximum driver pressure of 10,000 psi using inert gases. The driver section is 4 inches in diameter and 96 inches long. There are two driven sections available: a 3-inch-diameter round section in which a 20,000-psi reflected pressure step can be produced and a 3½-inch square section which is fitted with schlieren photographic windows. Both driven tubes have numerous instrumentation ports. A semiautomatic gas charging system is used to pressurize and fire the facility. (auth)

30334 (SLAC-70) TWO-DIMENSIONAL PATTERN DESCRIPTION AND RECOGNITION VIA CURVATURE POINTS. Zahn, C. T. (Stanford Linear Accelerator Center, Calif.). Dec. 1966. Contract AT(04-3)-515. 114p. Dep. CFSTI.

A method for obtaining descriptions of that class of two-dimensional pictures whose elements are a finite set of points in the plane each having value zero (white) or one (black) and such that the points are arranged in the form of some uniform lattice or

grid system is presented. The method is also shown to be able to handle grey-scale pictures. (B.G.D.)

30335 (TID-5059(7th Rev.)) CORPORATE AUTHOR HEADINGS USED BY THE U. S. ATOMIC ENERGY COMMISSION IN CATALOGING REPORTS. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1967. 143p. Dep. CFSTI.

An authority list of corporate names which is used by the Division of Technical Information of the United States Atomic Energy Commission for cataloging reports is presented. This list is the first to be printed from a computer-maintained file and is reproduced directly without the usual prepublication editing. (B.G.D.)

30336 (UCD-CNL-76) LOWER BOUND TO THE PRESSURE IN ONE-DIMENSIONAL SYSTEMS. Garrod, Claude (California Univ., Davis. Crocker Nuclear Lab.). Feb. 24, 1967. Contract AT(11-1)-Gen-10. 12p. Dep. CFSTI.

Using a minimum principle for the grand potential a lower bound is derived for the pressure of a one-dimensional gas as a function of temperature and chemical potential. (auth)

30337 (UCRL-7394) THE SUSAN TEST FOR EVALUATING THE IMPACT SAFETY OF EXPLOSIVE MATERIALS. Dorough, G. D.; Green, L. G.; Gray, D. T. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1965. Contract W-7405-eng-48. 34p. Dep. CFSTI.

The Susan Test is described and investigated. Test results on Comp B-3, Cyclotol 75/25, LX-04-1, Octol 75/25, PBX-9010, PBX-9011, PBX-9404, and TNT are given. Other tests pertinent to impact safety are discussed also. (auth)

30338 (UCRL-17525) INVARIANT SURFACES OF ORDINARY DIFFERENTIAL EQUATIONS WITH AND WITHOUT TIME LAG. Schaeffer, Anthony J. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1967. Contract W-7405-eng-48. 76p. Dep. CFSTI.

Thesis.

Consider the system of differential equations (1) $\dot{\theta}(t) = \Theta[\theta(t-r), x(t-r), \epsilon]$ and (2) $\dot{x}(t) = A[\theta(t-r), \epsilon]\, x(t-r) + X[\theta(t-r), x(t-r), \epsilon]$, where $r = 0$ when there is no time lag. A mapping $S: R^m \to R^n$ is an invariant surface of (1,2) if the pair $\{\psi(t), S[\psi(t)]\}$ is a solution of (1,2) where $\psi(t)$ is a solution of the equation (3) $\dot{\theta}(t) = \Theta\{\theta(t-r), S[\theta(t-r)], \epsilon\}$, which must be defined for all time if $r > 0$. For $\epsilon = 0$, it is assumed that $S_0(\theta) \equiv 0$ is an invariant surface of (1,2) and it is shown that under suitable conditions on Θ, A, and X there exists a unique invariant surface of (1,2) near S_0 for ϵ small. The essential conditions on Θ, A, and X are that: all be differentiable with respect to x and θ; no characteristic roots of A ever be purely imaginary, and A not depend on θ if there is time lag; and X have a small linear term, plus higher order terms, in x. More general time lag terms are allowed and a systematic treatment of differential equations with time lag is given. (auth)

30339 (UCRL-70195(Rev.1)) SURVEY OF GRAPHIC DATA PROCESSING EQUIPMENT FOR COMPUTERS. Cralle, Robert K.; Michael, George A. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1966, Revised: Apr. 1967. Contract W-7405-eng-48. 77p. Dep. CFSTI.

This report says in a variety of ways that computer-based graphic data processing is the wave of the future and that the chief problem encountered is trying to make it available to many people is ultimately its high cost. Whether these come down very much or not, there also will always be a corresponding level of technical difficulties that have to be surmounted. Some of the problems recognized so far are discussed and a brief survey of some of the equipment currently available is presented. (auth)

30340 (WAPD-TM-668) CDC-6600 FORTRAN PROGRAMMING: BETTIS ENVIRONMENTAL REPORT. Pfeifer, C. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 88p. Dep. CFSTI.

A description of routines which extend the FORTRAN language is given. This extension is for the most part one of convenience and efficiency. In particular, packages of routines which are used by FORTRAN programs for decimal input/output, file maintenance, scratch input/output, storage allocation, program loading and other auxiliary functions are described. Some discussion on the reasons for the particular methods employed in these packages is included. (auth)

30341 (AEC-tr-6853) HISTORY OF THE FRENCH NUCLEAR EFFORT THROUGH 1965. Translated from Energ. Nucl. (Paris), 7: 451-3; 455-83; 485-97; 499-505; 507-27; 529-36 (Dec. 1965). 203p. (NP-tr-1392). Dep. CFSTI. JCL $14.00 fs, $6.29 mf.

The history of the French nuclear effort in the last 20 years is reviewed under the following headings: the role of the French Atomic Energy Commission in the development of French atomic power, twenty years later, the French industrial effort, the uranium mining industry in France, research on materials, basic physics research, study and construction of nuclear reactors from ZOE to RAPSODIE, industrial manufacturing of fuel elements in France, and nuclear electricity in France. (M.C.G.)

30342 LAW RELATING TO NUCLEAR ENERGY. Street, H.; Frame, F. R. London, Butterworths, 1966. 320p. 110s.

Topics covered include: organizations in the U. K., licensing of nuclear installations in U. K., civil liability arising before 1965 from operation of nuclear installations, civil liability arising after 1965 from operation of nuclear installations, use of radioactive materials, transport of radioactive materials, international organizations, liability arising from operation of nuclear installations outside U. K., nuclear ships, patents, and statutes and conventions relating to nuclear energy. (UK)

30343 THERMAL ANALYSIS 1965. Proceedings of the First International Conference, Aberdeen, Scotland, 6-9 September, 1965. Redfern, J. P. (ed.). New York, St. Martin's Press, Inc., 1966. 306p. (CONF-650914).

Summaries of the papers presented at the First International Conference on Thermal Analysis are presented. The various aspects of thermal analysis covered by these papers are instrumentation of organic materials including polymers, inorganic materials and metallurgy, physical chemistry and quantitative aspects, minerals, and applied sciences (building materials, ceramics, etc.). (B.G.D.)